QUARTERLY JOURNAL

OF THE

ROYAL METEOROLOGICAL SOCIETY.

EDITED BY

A COMMITTEE OF THE COUNCIL.

VOL. X.

1884.

LONDON:
EDWARD STANFORD, 55 CHARING CROSS, S.W.;
WILLIAMS AND STRAHAN, 7 LAWRENCE LANE, E.C.
1884.

LONDON:
PRINTED BY WILLIAMS AND STRAHAN,
7 LAWRENCE LANE, CHEAPSIDE.

TABLE OF CONTENTS.

LIST OF PLATES.

ERRATA.

Page 180, Table III. July H. 1880, *for* 9,811 *read* 9,154.
„ Table IV. July H. 1879, *for* 19,818 *read* 12,818.
„ „ „ 1880, *for* 12,140 *read* 19,140.

QUARTERLY JOURNAL

OF THE

ROYAL METEOROLOGICAL SOCIETY.

VOL. X. JANUARY 1884. No. 49.

REPORT ON TEMPERATURES IN TWO DIFFERENT PATTERNS OF STEVENSON SCREENS. By EDWARD MAWLEY, F.R.Met.Soc., F.R.H.S.

[Read November 21st, 1883.]

As this paper is, with the exception of a few additions, a Report prepared at the request of the Council of this Society, it may be advisable to preface it with some particulars respecting the two screens and the differences between them.

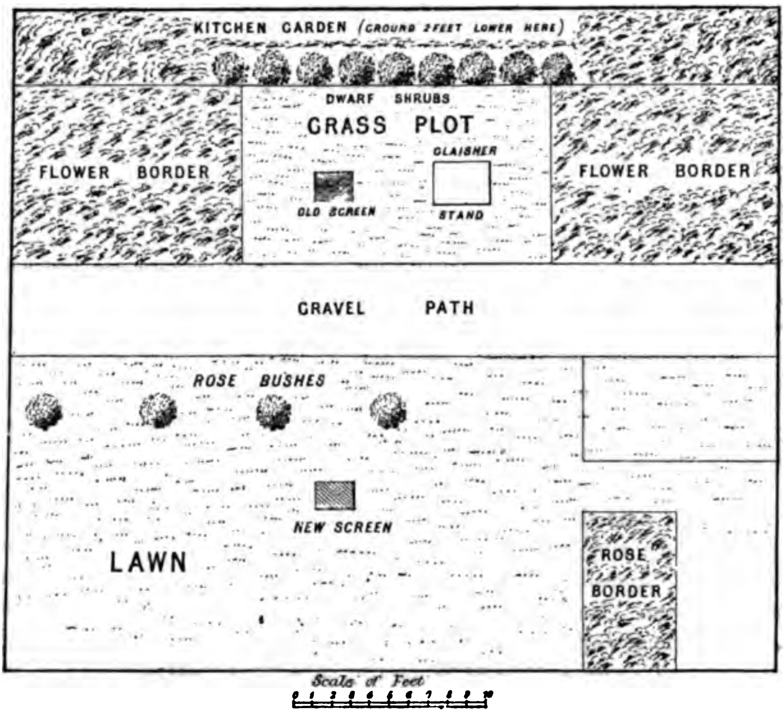
The thermometer screen referred to in this Report as the "old" screen is an ordinary Stevenson screen obtained from Casella about seven years ago, while the one called the "new" screen is a Stevenson screen made in May last by a local carpenter, in accordance with the recommendations of a Committee appointed by the Council of this Society.

The internal dimensions of the old screen are as follow:—width, 16 ins.; depth, 9 ins.; and height, 16½ ins. Those of the new screen:—width, 18 ins.; depth, 11 ins.; and height, 16½ ins. Accordingly, while both screens are the same height inside, the new one is 2 ins. wider and 2 ins. deeper than the old screen. The new screen also differs from the old screen in the following principal points. The inner and outer louvres, instead of being separated, are joined at their upper edges. The inner louvres are 1¼ in. in width, and the outer ones 2¼ ins.; whereas those in the old screen are both only 1¼ in. wide. The distance between the louvres has also been increased to a clear ½ in. in the new against ⅜ in. in the other screen. The new screen has an upper sloping roof, and at a little distance below a flat inner roof, pierced with holes for ventilation; while the old screen has a single flat roof,

with only a narrow slit beneath on each side for ventilation. The bottom of the new screen is formed with three small boards, the two outer ones overlapping the inner one in such a way as to completely cut off direct radiation from the ground; whereas in the old screen there is only one narrow board running across the centre of the bottom.

Observations have been taken in both screens, with a few exceptions, three times a day for five months (June 16th to November 16th). In the present report those made during July, August, and September only have been discussed.

Relative Positions of the two Screens.—Both screens were on a level piece of ground, and during no part of the day was either of them shaded by any higher object. The new screen was placed 5 yds. South of the old screen, towards the North-east corner of a lawn 18 yds. square; while the old screen remained in the same position it has occupied for some years, namely, 4 ft. to the West of a Glaisher stand on a grass plot 16 ft. long by 9 ft. wide. As will be seen in the accompanying plan, the grass plot is separated from the lawn by a gravel path, 5 ft. wide.



Plan, showing position of Screen.

The Painting of the Screens.—Previous to the observations being made the new screen received two coats of white lead paint and a finishing coat of

white zinc paint and copal varnish, while the old screen was repainted throughout and finished off with the same mixture as the new one.

The Thermometers.—The different thermometers occupied similar positions in the two screens, and were respectively the same heights above the ground. The only difference in the thermometer bulbs likely in any way to have affected the results was in the case of the minima, the minimum thermometer in the new screen having a cylindrical bulb, whereas that in the old screen has a forked bulb. On the 9th of October all the thermometers were several times tested most carefully in melting ice, and appropriate slight corrections made in their certificates.

Circulation of Air.—After the thermometers had been removed from the new screen a few observations were taken in both screens with a miniature Robinson anemometer lent by the Kew Committee, and these were compared with the indications of another Robinson anemometer on the top of the Glaisher stand. Little value should, perhaps, be placed upon such comparisons, as they necessarily vary with every wind that blows, and moreover greatly depend upon the position occupied by the anemometer in the screen. Still it may be of interest to state that on the afternoon on which these observations were made, with a South-westerly wind moving outside at the average velocity of about 5 miles an hour, the mean rate of movement inside the two screens was about 1 mile an hour in the old screen and about 1¼ mile an hour in the new one.

Comparative Amount of Light in the Two Screens.—In order to test this, small pieces of sensitive paper were, on one bright day in October, fastened to small boards attached to the middle of the doors of both screens. After two hours exposure, viz. from 11 a.m. to 1 p.m., the papers were removed, and the one in the new screen was found to have assumed a deeper tint by several shades than the paper in the old screen.

Concluding Remarks.—During the severe Southerly gale of the 2nd of September a few drops of rain were driven through the South louvres of both screens, but no more through one screen than the other. The upper roof of the new screen during the time it has been in use has not warped at all, but previous to the screen being painted it had become slightly curved upwards in the centre.

As regards coolness, from the mean results the two screens come out very much alike. But when the individual temperatures are compared, I find that on no less than thirty-four out of the whole ninety-two days the thermometers in the new screen read at some time half a degree or more lower than those in the old screen; whereas on only ten days altogether did any reading in the old screen fall below a similar reading in the new one by half a degree or more. The two screens seem to be about equally cool at night and also at 9 a.m. During the hottest part of the day, however, and also at 9 p.m., the new is somewhat cooler than the old screen. The mean temperatures, whichever way reckoned, come out slightly lower from the new screen readings, as does also the daily range.

To sum up, the new screen may be regarded as possessing the following

advantages over the one now in general use. It is slightly cooler and better ventilated. It is also stronger, more roomy, and has a better appearance. Having a double roof and overlapping boards below, it is at the same time better suited for extreme climates. In my opinion, however, its principal advantage will be found to consist in its retaining the heat of the sun for a less time than the old screen. This is seen from the fact, that during July and August, while the dry-bulb temperatures were as a rule about the same at 9 a.m. in both screens, at 3 p.m. they come out 0°·14 lower and at 9 p.m. as much as 0°·23 lower in the new screen than in the old one.

ABSTRACT OF RESULTS.

NEW SCREEN ABOVE OR BELOW OLD SCREEN.

1883.	Mean Temperature.							
	Max.	Min.	9 a.m.	3 p.m.	9 p.m.	Daily Mean. Max. and Min.	Daily Mean. 9 a.m. and 9 p.m.	Daily Range.
	°	°	°	°	°	°	°	°
July	−0·13	+0·03	+0·07	−0·13	−0·23	−0·05	−0·08	−0·16
August	−0·05	0·00	+0·02	−0·15	−0·23	−0·03	−0·10	−0·05
September	−0·14	−0·01	−0·05	−0·18	−0·06	−0·07	−0·06	−0·13
Means	−0·11	+0·01	+0·01	−0·15	−0·17	−0·05	−0·08	−0·11

1883.	Mean Reading of Wet Bulb.			Mean Difference between Dry and Wet Bulb.		
	9 a.m.	3 p.m.	9 p.m.	9 a.m.	3 p.m.	9 p.m.
	°	°	°	°	°	°
July	+0·06	+0·06	+0·04	+0·01	−0·20	−0·26
August	−0·05	−0·15	−0·08	−0·07	0·00	−0·15
September	0·00	−0·08	+0 03	−0·05	−0·10	−0·09
Means	0·00	−0·06	0·00	−0·04	−0·10	−0·17

DISCUSSION.

Rev. F. W. STOW in a letter to the Secretary said, "Mr. Mawley's comparison seems to be very satisfactory, the slight difference being in the direction expected. I have copied out a comparison of my zinc screen which was returned from the Society's office in May, and my old wooden screen. The former you know,[1] except that it received a better roof, over-hanging further in all directions, and that I altered the bottom boards and made them after the pattern screen. It received also three good coats of paint. The wooden screen is 3ft. 6ins. long and has a large double roof, louvres 2¼ ins. wide by ¼ in. thick, and ¼ in. apart; a single row in front and sides, a double row at back, the outer louvres being 3 ins. wide. I made it in 1871. The ground on which the screens were placed slopes towards South-east, and the zinc screen was higher up. The results of the comparison during the three months, July to September 1883, are the following :—

[1] *Quarterly Journal*, Vol. VIII, p 228.

1883.	Maximum.			Minimum.		
	Zinc Screen.	Wooden Screen.	Diff. of Zinc from Wood.	Zinc Screen.	Wooden Screen.	Diff. of Zinc from Wood.
July	60°·90	60°·87	+°·03	46°·05	46°·06	−°·01
August	62·93	62·79	+·14	48·08	48·15	−·07
September	64·46	64·38	+·08	48·94	48·96	−·02

"I think these figures may be of interest as showing that good sized screens agree whatever the material."

Mr. SYMONS considered the new screen an improvement in every way over the old Stevenson screen, and as it only cost five shillings more than the ordinary Stevenson screen, there would be but little difficulty in inducing observers to adopt it.

Mr. GASTER was very glad that the results of the comparison showed that the temperatures recorded in the new screen did not differ much from those in the Stevenson screen, as it would be very serious if a new screen were to be introduced, with the Society's authority, differing materially from one which is so universally used in this country. He thought that the louvres in the new screen being joined together, would make it easier for rain to get inside; and if the inner roof had been solid, instead of being pierced with holes, the results of the comparison might have been even better than they were. As it is, however, the difference between the temperatures in the two screens is very much smaller than the differences which sometimes exist between verified thermometers themselves. In April 1880 he had made some experiments with two precisely similar Stevenson screens, placed 18 ins. apart, one of which was protected with a large umbrella from the heat of the sun, while the other was fully exposed. On one morning, at 8 a.m., the dry bulb thermometers hung on the East side of each screen, read alike; at 10 a.m. the thermometer in the unprotected screen read 0°·9 higher than that in the protected screen; at 10.45 a.m. 1°·1 higher. A thermometer was then hung at the back or South side of each screen, and the differences between these thermometers were as follows:—the thermometer in the unprotected screen at 10.30 a.m., read 2°·3 higher; at 10.45 a.m. 2°·6; at 11.15 a.m. 2°·5; and at 11.30 a.m. 2°·6. This seemed to show that although by adopting the Stevenson screen we got uniformity in exposure, but we did not get accuracy. In showery weather, too, the rain lying on the louvres would damp the air passing through them, and so cause the hygrometer to show a greater degree of humidity than was actually the case. It is in calculating averages, and from them drawing isothermal charts, that differences due to bad screens become so serious; an error of even 0°·5 being sufficient to distort an isotherm. It is absolutely necessary to get the best screen possible, and the question is, how far should thermometers be surrounded by louvres? He believed there should be as little louvre board as possible in a thermometer screen, and his idea of a proper thermometer screen was a treble roof with slight louvres on the East and West sides, so as to protect the thermometers from either direct, or reflected heat; the ground beneath being sheltered from the direct solar rays, by means of an independent screen placed at some distance from the instruments. By these means a perfect circulation of air in its natural condition would be insured, and reflected heat from the ground be got rid of.

Dr. MARCET had observed that the sun heated screens exposed to its rays, and at Cannes, where he had taken observations daily during six winters, he had on that account to remove his screen from the front of his house facing South, to the back, so as to keep it in the shade. A gentleman, a Fellow of this Society, also residing at Cannes had a hut made to protect his screen from the sun's heat, and he (Dr. Marcet) thought that if it was necessary to use a sheltered screen in the South of France, such a precaution was equally required in this country. Mr. Gaster's remarks certainly showed that the readings of thermometers in the Stevenson screen under ordinary circumstances were too high. The new screen

was an advantage over the old one as regarded the roof, but the louvres seemed to be rather too close.

Prof. ARCHIBALD considered that before the Society pledged itself to a new form of screen, which was seen by Mr. Mawley's experiments to differ so minutely from the one now in use, the whole theory of screens ought to be reconsidered. For his own part he was surprised at the strange variations in the exposure of thermometers adopted in different parts of the world. In India the screens were always placed under a shed, like the one described in Mr. Blanford's *Vade Mecum*, Part I. It was obvious that in India a thermometer in an unprotected screen would register very differently to one in a screen under such a shed, which protected it from the fierce tropical sun by the interposition of a thatched roof. Even in this country he thought there would be found to be a considerable difference between the readings of thermometers in protected and unprotected screens, especially in the summer; and in the absence of special trials hitherto on this point would advise the Society to make some fresh ones. If protecting sheds were dispensed with, he thought the screens themselves ought to be constructed so as to afford complete shelter from solar and terrestrial radiation. This would be better acccomplished, he thought, if the existing screen were made with vertical eaves reaching more than half way down the screen, and about 2 or 3 ins. from it. This would shelter it from the morning and evening sun, which the present screen ignored, and then the louvres could be made more open with safety, and inclined upwards, so as to shelter from terrestrial radiation.

Capt. TOYNBEE was pleased to find so close an agreement between the two screens, showing that observations taken in them at various stations must give very valuable relative temperatures, even though slightly different results might be obtained if a more perfect screen were devised. He would be glad to know if a complete series of comparisons had been carried out between sling dry and wet bulb thermometers, and others placed in a Stevenson screen.

Mr. SYMONS referred to the observations made with different patterns of thermometer screens which were commenced ten years ago at Strathfield Turgiss. Among these there was a thermometer stand covered with a thatched roof similar to the mode of exposure adopted in India. The observations had been discussed by Mr. Gaster, and the results published by the Meteorological Office. This comparison, however, did not include the form of stand used at the Montsouris Observatory, Paris, and generally in use in France. From what he knew of that screen, he thought it was very much like Mr. Gaster's idea of a screen; but the Montsouris stand was intended to be sheltered on the South by shrubs, an arrangement open to question upon hygrometric grounds. Dr. Marcet's plan of placing his thermometer stand in the shade of a house did not commend itself to him, for the temperature in such shade would not be the true temperature of the air.

Lieut.-Gen. STRACHEY remarked that the necessity of screens mainly arose from the imperfection of thermometers, glass, the material of which they were made, being extremely sensitive to radiation. What was required was a thermometer bulb not susceptible to radiation, and it would be well worth trying to construct such an instrument. He had indeed seen a thermometer, the bulb of which was covered with polished silver, which appeared to give promise of success in this direction. But the silver coating failed, and the attempt had not been followed up.

Dr. MARCET said it was the temperature of the air entirely free from the direct influence of the sun which was required, and he did not quite understand the objection there was to the use of a house (isolated at all events on one side) as a means of sheltering a screen from the sun's rays.

THE PRESIDENT (Mr. LAUGHTON) said that the discussion had turned on the exposure of thermometers rather than on the comparison between the two particular screens. This was really foreign to the subject of the paper, and to the work which the Committee had been requested to undertake, which was solely to recommend an exact pattern of Stevenson screen, with the view of obtaining something like uniformity at the Society's stations. Whether Stevenson screens give the best possible exposure was quite another question, on which meteorologists might perhaps be agreed some day; but till then, it is most desirable that they should all be of the same size and pattern.

Mr. MAWLEY was pleased to find that the new screen had the approval of so excellent an authority on the subject of thermometer exposure as the Rev.

F. W. Stow was well known to be. There could be no doubt that shaded screens would during the hottest months of the year give somewhat lower readings than those that were unprotected, but it should also be remembered that, when shading a screen in the way which had been described, the ground beneath and around it was at the same time shaded. And as it was not to be expected that, even if this plan were adopted, all observers would shelter their screens to the same extent, or in precisely the same way, the results obtained in different localities would be less comparable than under the present system. For his own part, his recent investigations had only confirmed him in the favourable opinion he had already formed of the Stevenson screen, as a means of thermometer exposure for general adoption. As to the objection that rain could enter the new screen more easily than the old one, he stated that on only one occasion did any rain find its way into the new screen, and that was during the heavy Southerly gale of September 2nd, whereas on another windy day, in November, while the new screen remained perfectly dry inside, a few drops of rain were found trickling down some of the inner louvres of the old screen. This he attributed to the greater depth of the outer louvres in the new screen. With regard to its cost he mentioned that he had had several made, the price being £2 in each case, and considering that this screen was somewhat larger, more strongly made, and better painted than the screens usually sold, he considered it would be found in the end quite as inexpensive. He had noticed that the differences in the indications of the thermometers in the two screens did not take place as might have been expected on the hottest days, but generally on days of moderate heat. It having occurred to him, after the comparisons given in the Report had been made, that perhaps the differences in the positions of the two screens might have to some extent influenced the results, he had the old screen removed to within a few yards of the new one, but found that the differences in the readings continued much as before. In fact, so slight were these differences, that the changing of the thermometers from one screen to the other was found to make a greater difference than the relative positions of the screens themselves. As compared with the original Stevenson screen, described in the first volume of the *Journal of the Scottish Meteorological Society*, the new screen, taking the inside measurements was 3½ ins. wider, 3½ ins. deeper, and 1½ in. higher.

On the Storm which crossed the British Islands between September 1st and 3rd, 1883, and its Track over the North Atlantic. By Charles Harding, F.R.Met.Soc. Communicated by permission of the Meteorological Council. (Plates 1 to 9.)

[Read November 21st, 1883.]

The violence of the Storm which traversed the British Islands, September 1st—3rd, together with the damage which it caused, chiefly owing to its occurrence before the completion of the harvest, have led me to suppose that a discussion of this Storm would be acceptable to the Fellows of the Society.

The Fellows are doubtless aware that the Meteorological Council made a special collection of observations from ships in the North Atlantic for the period from August 1st, 1882, to August 31st, 1883, and have kindly granted me permission to use some of their valuable records for the preparation of this paper.

By means of the ships' observations the path of the storm can be tracked from within the tropics and across the Atlantic from coast to coast, and it is

hoped that this, coupled with the rapid rate of progress and the marked manner in which the depression not only deepened but extended in its area, will prove of interest, if not even of scientific value.

At present, very scant data have been received from a more southern latitude than 25° N; but there is sufficient to track the storm well into the tropics.

The first evidence of the storm is from the steam ship *Haytian*, bound to the south-west. On the 23rd of August, at 4 a.m., in 22° 45′ N and 55° 45′ W lightning was seen in the south-west, and a fresh East-south-east wind in the morning increased to a moderate gale by noon, barometer 30·10 ins.—position of ship 22° N and 57° W. On the 24th at 8 a.m. it was blowing a fresh gale from East-south-east—barometer 29·97 ins.—and at noon the wind had increased to a strong gale from the same direction, barometer 29·98 ins.—ship in 21° 18′ N and 58° 14′ W. The *Haytian* was under the influence of this gale on the 25th in 20° N and 60° W., but the barometer had then risen. At Sombrero Island, West Indies, in 18° 36′ N and 63° 28′ W a high sea on the north-east side of the island was reported at noon on the 23rd; but nothing of any note occcurred in wind or weather.

The Barque *Active*, on August 26th, in 24° 30′ N and 67° 30′ W, experienced a strong North-westerly gale, and at 4 p.m. recorded the lowest barometric reading 29·55 ins. The two following extracts are from *Lloyds' List* :—

The *Paolina*, Italian barque, reports that from August 25th to the 28th, lat. 25° 49′, long. 62° 23′, to lat 28° 42′, long. 68°, she experienced a heavy gale from South-east to North-west, West, and South-west, during which she stove bulwarks, lost sails, &c.

The *Maggie Glenn* brig was abandoned August 28th, having encountered a fearful hurricane August 26th in lat. 25°, long. 65°; during which she was thrown on her beam ends and had masts cut away.

Accordingly, as early as August 24th the storm had the force of a strong gale in lat. 21° N, and on August 26th in lat. 25° N it was blowing with hurricane violence. From this time until September 4th, when the storm-centre had traversed England and was situated over the North Sea, its path can be fixed with the greatest certainty, not only by means of the charts which have been drawn for 8 a.m. local time each day, but also by the extracts from the ships' logs (see pp. 12-14) as well as the extracts from *Lloyds' List* (see pp. 14-16), which give very frequently the time of lowest barometer reading, and the sudden change of wind consequent on the passage of the storm-centre. These extracts also throw considerable light on the development of the storm as it progressed over the North Atlantic. When this discussion was commenced the track was worked out by means of the several barometrical minima and the sudden changes of wind experienced, and it has not since required alteration; for the centres of disturbance obtained from the daily charts fall absolutely on the track as originally drawn. The path of of this storm, which is throughout numbered IV. and V., is shown by a plain bold line on the Track Chart. (Plate 9.)

The Chart of August 27th (Plate 1) shows that an area of low pressure (No. IV.) existed somewhat beyond the limits of the chart. It is indicated

by the trend of the isobar for 30 ins. in the lower left-hand corner; the American *Tri-Daily Weather Map* also shows that an area of low barometer (No. V.) is travelling eastwards over the Continent of America, and at 7 a.m. of Washington Time was situated in about 49° N and 97° W. On the 28th (see Plate 2) the low pressure (No. IV.) had moved further to the North. It is now fully shown on the chart, the centre of the disturbance having been apparently at about 30° N and 69° W; and although the depression seems to have been shallow still several vessels were experiencing a gale. The steamship *Euripides*, No. 162, gives good evidence of the position of the centre (see extracts from logs for 28th). The depression (No. V.) which on the 27th was situated about the centre of the United States, had now advanced to the eastward, and had its centre slightly to the south of Chicago. On the 29th (see Plate 3) the depressions No. IV. and V. appear to have merged; and instead of two shallow depressions we now have one much deeper and considerably larger in extent. The chief strength of the gale would, however, seem to have been due to a somewhat high pressure on the American coast, causing a steep gradient on the northern and north-western parts of the storm-area. The barometer near the centre of the storm read 29·5 ins. at 8 a.m., as shown by the chart; but the extracts from the ships' logs as well as those from *Lloyds' List* show that the depression was rapidly becoming deeper and the storm more violent: see especially the extract from the barque *Slieve Bloom* (No. 147), p. 12, which shows that the barometer had fallen from 30·14 ins. at 6 a.m. to 28·80 ins. at 4 p.m., a fall of 1·34 ins. in 10 hours. An area of high barometer reading (30·3 ins. and upwards) occupied a considerable space in the middle of the Atlantic, and the readings in this high pressure area were higher than those on the 28th. Whether the increase shown is connected with the decrease of pressure in the storm which is skirting it, is a matter of interest which might well be studied.

This area of high pressure is not one of the travelling areas. It is permanent in character and in position, except that it is subject to variation in intensity, and to a slight oscillatory movement; being of a much more pronounced type at one time than another. It is subject to change with the season, as are the Trades and Doldrums, being situated furthest northwards in August.

On the 30th, (see Plate 4) the centre of the disturbance is situated off Cape Breton, to the south of Newfoundland; and had travelled N 30° E 640 miles in the past 24 hours. The steepest gradients and consequently strongest winds would appear to have been in the south-eastern quarter of the storm area, this is due to the somewhat close proximity of the high pressure area in Mid-Atlantic. The depression gradually became deeper and the gradients steeper, and the area over which the gale force was experienced was considerably extended; the Barque *Maiden City*, No. 126, had a reading of the barometer as low as 28·55 ins. (see extracts from Ships' Logs, p. 12). Little change is shown in the area of high barometer readings in Mid-Atlantic. On the 31st (see Plate 5) the storm had made further progress to the eastwards (N 76° E) of about 910 miles, and had considerably increased in

extent. The barometer near the centre, as shown by the chart, was reading as low as 29 ins., and the wind was blowing with full force at a distance of over 700 miles from the centre. The gradients had become much steeper, especially in the north-western quadrant.

The steamship *Carbis Bay*, No. 62, recorded that the barometer fell from 30·15 ins. at 3 a.m. to 28·45 ins. at 6.40 p.m. ; a fall of 1·70 ins. in 15 hrs. 40 mins. (see extracts from Ships' Logs, p. 13).

The ridge of high pressure, which on the 30th was situated to the eastward of the storm, had become much less marked, although the permanent area of high pressure in Mid-Atlantic had increased as far as absolutely higher readings were concerned.

On September 1st, (see Plate 6) the centre had made a further advance to the eastwards (S 89° E) of about 1,000 miles in the 24 hours, and a still further development of the storm area had taken place. The barometer near the centre, as shown by the chart, was reading as low as 28·28 ins., and winds of gale force were felt at 600 miles from the centre of disturbance. The wind was blowing with the force of a gale over a much greater area in the rear of the storm-centre than in its front, although the steepest gradients were in the front, which was due apparently to the centre of the depression impinging more closely upon the ridge of high pressure to the east of it, as well as to the reduction of actual pressure at the centre of disturbance. The steam ship *British Crown*, No. 129, recorded the barometer 29·70 ins. at 5 p.m. 31st, and 28·25 ins. at 3 a.m. 1st, a fall of 1.45 ins. in 10 hours (see extracts from Ships' Logs, p. 13). On the 2nd (see Plate 7) the rate of progress of the storm-centre had considerably decreased, its advance in the 24 hours having been only about 380 miles to the east-north-eastward. The steepest gradients and consequently strongest winds were now in the southern part of the storm area, and the whole of Western Europe was brought under the influence of the storm. The process of filling up had, however, already commenced, for the reading of the barometer near the centre at the time of the chart was only 28·5 ins.

The extracts from *Lloyds' List*, as well as those from the *Times*, show very clearly the positions in which the gale was most severe whilst within the area of the British Islands.

The progress of the gale is well shown by the reports from the various land stations of the Meteorological Office.

The observations at the seven self-recording observatories afford the most exact data both of the first indications of the approach of the storm and of the passage of the centre of disturbance. The first evidence of its approach was shown at Valencia at 8 p.m. on the 31st, at which time the barometer began to fall. The times at which the barometer began to fall at the several other observatories were—Falmouth, 10 p.m., 31st; Stonyhurst, 10 p.m., 31st; Armagh, 0 a.m. (midnight), 1st; Glasgow, 0 a.m. (midnight), 1st; Kew, 9 a.m., 1st; Aberdeen, noon, 1st. The passage of the storm-centre is shown by the time of the occurrence of the minimum barometer readings (all corrections have been applied). The readings were—

Valencia 28·49 ins. at 7.15 p.m., 1st; the barometer at its lowest from about 6 p.m. to 10 p.m., 1st. Armagh 28·75 ins. at 5.40 a.m., 2nd; the barometer at its lowest from about 3 a.m. to 8 a.m., 2nd. Falmouth 28·50 ins. at 5.45 p.m., 2nd; the barometer at its lowest point from 2 to 7 a.m., 2nd. Stonyhurst 28·67 ins. at 4 p.m., 2nd; the barometer at the lowest point from 2 to 6 p.m., 2nd. Glasgow 28·83 ins. at 4 p.m., 2nd; the barometer at its lowest point from noon to 6 p.m., 2nd. Kew 28·78 ins. at 4 p.m., 2nd; the barometer at its lowest point from 2 to 4 p.m., 2nd. Aberdeen 28·94 ins. at 5.30 p.m., 2nd; the barometer at its lowest point from 5 p.m. to midnight, 2nd.

The Daily Weather Report stations of the Meteorological Office do not show any indication of the approach of the storm until 8 a.m. of September 1st; at which time the centre of the disturbance was in about 49° 15′ N. and 14° W., or about 200 miles to the south-west of Valencia; at this time the winds at our westernmost stations were South-easterly, but the force had not yet attained the strength of a gale. The lowest barometer reading was 29·06 ins. at Valencia, and the trend of the isobars clearly indicates the near approach of a deep depression. By 10 a.m. the barometer at Valencia had fallen to 28·91 ins., and by noon to 28·75 ins., and the wind had now reached the force of a moderate gale from East-south-east. At Scilly the gale began at 11.30 a.m. At 6 p.m. the centre of the storm was situated about due south of Valencia, and the barometer at that station was 28·50 ins.; the gale had now reached stations in the south-west of England as well as in the north and west of France. On the 2nd, at 8 a.m., the centre was just to the south of Pembroke, at which station the barometer stood as low as 28·44 ins.; the winds over the whole of the United Kingdom as well as over a great part of Western Europe circulated round the centre of depression. The strongest force was experienced over the south-west and south of England and over France, but the fact that with this position of the storm-centre an East-north-easterly gale was blowing at Stornoway, and a South-westerly gale at Biarritz, and also at Corunna, as shown by the chart, will give some idea of the extent of the disturbance. At 6 p.m. the centre was apparently lying over Cheshire, the lowest barometer reading shown by the Daily Weather Report stations was 28·66 ins. at Loughborough, and at Liverpool the reading was only 28·68 ins.; and the position of the centre was fairly midway between these two stations; the winds, however, for some considerable distance round the centre were light, owing to the uniformly low readings and consequently slight barometrical gradients. The gale was still very heavy in the West and South of England as well as over France and Germany, and had reached Norway. The rain accompanying the gale was very heavy, at Roche's Point as much as 1·9 ins. fell from 8 a.m. 1st, to 8 a.m. 2nd. On the 3rd at 8 a.m. (see Plate 8) the storm-centre was over the North Sea off the north-east coast of Scotland, having travelled 360 miles in the last twenty-four hours, and the process of filling up is more clearly shown, as the barometer at the centre recorded 29·0 ins. The gradients were less steep than on the 2nd, but still it was blowing a strong gale over the whole

of the south of England, and pretty generally over the west of Europe. The 2 p.m. and 6 p.m. observations confirm the fact that the depression was being filled up, and show that the gale had almost entirely expended itself—the centre had still progressed to the North-eastward, but its rate of travelling is extremely slow. The charts for the 4th show the depression was being still further filled up, and the rate of progress, now to the Northward, was also slower, although on the coast of Norway the wind still retained the force of a gale.

The following are extracts from the ships' logs. They give important facts, such as the height and time of the lowest barometer reading, and the change of wind experienced in connection with the storm centre, Nos. IV. and V. They have a very important bearing on the track of the storm, and also enable one clearly to trace the history of the development of the storm as it moved across the Atlantic. They are arranged in order of date, and the extracts from the westernmost vessels are generally given first each day.

AUGUST 28th.

(162) 6 a.m., in 30° 35′ N and 65° 25′ W, hauled ship out to South-east to clear storm track, the squalls getting very violent and glass falling rapidly from previous midnight—barometer ceased falling, and soon after altering course began to rise. Noon, South-east by East, 9, barometer 29·80 ins.

(57) Noon, in 35° 45′ N and 72° 45′ W, wind North-north-east, 8-9, a terrible confused sea from North and East-south-east.

AUGUST 29th.

(132) The hurricane commenced at 6 a.m., ship in 41° N and 65° W, and lasted till 6.30 p.m., at the end the wind was North-north-west. Ship in 41° N and 66° W. Wind at noon North-east, 12.

(32) Noon to 6 p.m., in 41° N and 66° to 67° W, heavy Northerly gale, hurricane force at times, barometer lowest, 28·95 ins., at 3.20 p.m., in 41° N, 66° 30′ W.

(147) 6 a.m., took in everything but the lower topsails, barometer 30·14 ins. and slightly falling, wind at East-south-east, force 9, weather gloomy and oppressively hot. At 8 a.m., in 38° 50′ N and 63° 45′ W (see Chart) the force of the hurricane was upon us, lower topsails and mizen staysail were blown away in a few moments, cargo shifted, and then we lay with the shearpoles of the lee rigging under water; as for the rail we did not see it once in half-an-hour, the sea was constantly over the top of our house to leeward, spars washed adrift and everything movable washed away; have been round an Indian hurricane but never saw anything like this, could not see the length of the ship for spoondrift. Noon, ship's approximate position 38° 50′ N and 63° 35′ W. About 1 p.m., a mountain of water struck the ship, doing immense damage and washing the captain overboard, but he found a round turn of the main brace round his leg by which he was enabled to scramble on board again. 4 p.m., barometer at its lowest, 28·80 ins., after 4 p m. the mercury rose very fast, and by 10 p.m. the force of the gale was gone. Ship was hove-to on starboard tack, the wind remained steady longest at South-east, and when its force began to moderate the direction was South-south-west.

(37) 2 p.m. till 7 p.m. Hurricane from North-north-east to West-north-west, lowest barometer 29·10 ins. from 5 to 6 p.m., wind North-north-west, 12, in 41° 30′ N, 66° W.

(23) Noon, in 40° 45′ N, 67° W, strong gale and continuous thick rain with very high confused sea. 6 p.m., in 40° 50′ N, 66° 30′ W, lowest barometer 29·22 ins., gale suddenly moderated at North-north-east and hauled to West-north-west, leaving a frightfully high confused sea. Barometer rose steadily from 6 p.m.

AUGUST 30th.

(126) In 41° 55′ N and 62° W the barometer fell to 28·55 ins. and blew a fearful hurricane, whilst the wind hauled from East-south-east to West when the wind began to abate and barometer to rise at 1.30 a.m. 30th.

(182) 2 a.m., in 45° 40′ N and 56° 30′ W, it began to blow very hard with the wind gradually going back to South-south-west and West-south-west, blowing with hurricane force from 3 to 7 a.m., wind being then South to South-west. Lowest reading of barometer 29·03 ins., at 4 a.m., in 45° 40′ N and 57° 0′ W, wind South-west, 10 to 11.

(31) 11 a.m., 29th, in 44° 40′ N, 52° 30′ W, wind changed from West to South, South-east, and East. 4 a.m., 30th, in 43° 40′ N, 55° 45′ W, wind East by South, 10. 5 a.m., lowest barometer, 29·34 ins., wind South by East, 10. 6 a.m., wind South by West, 11. At 8 a.m., in 43° 30′ N, 56° 30′ W, wind West by South, 11, barometer 29·48 ins. (see Chart).

(7) 0 a.m., in 45° N, 52° W, heavy rain. Yard-arms and mast-heads lit up with Corposants. 7 a.m., in 44° 30′ N, 55° W, sudden shift from South-east to South-south-west, force 7, barometer 29·66 ins. 11 a.m., in 44° N, 56° W, wind veered to Westward, force 10, barometer 29·48 ins. Noon, wind West, 10, barometer 29·55 ins.

(29) Noon, in 48° 45′ N, 50° 45′ W, hard squalls from East-south-east to South-east, force 10. 4 p.m., barometer 29·16 ins., wind calm. 6 p.m., in 48° 30′ N, 51° W, wind veered to North-north-east and blew a hurricane.

(161) 10 p.m., in 47° 15′ N and 48° W, lowest barometer 29·29 ins. Midnight, wind shifted from West to North-north-west in a squall, force 9, lasting about an hour.

AUGUST 31st.

(125) 2 a.m., in 50° 45′ N and 38° W, wind East-south-east, 10. 4 a.m., East-north-east, 10, with rain, barometer 29·12 ins.

(16) 6.30 a.m., in 49° 15′ N, 39° 45′ W, barometer 28·99 ins., sudden shift of wind from South-south-west to North-north-east, blew a perfect hurricane for 2 hours, then settled down into a hard gale, very high sea, washed away boat and lost all square sails. Barometer rose at a wonderful rate after 8 a.m.

(40) 8 a.m., in 49° 30′ N and 37° W, wind West-south-west, 9, barometer 29·10 ins., 9 a.m., wind North-west, 10, barometer 29·04 ins. At 10.15 a.m., wind flew to North-north-east, force 11 and 12, blowing a terrific gale till noon, when the worst was past. Noon, in 49° 15′ N and 36° 45′ W, wind North-north-east, 11, barometer 29·50 ins., the captain remarks that he cannot describe the confused state of the sea that was coming from North-east, North-west, and South-west.

(171) 4 p.m., gale increasing with furious squalls and rain, wind West-south-west, 10, barometer 29·17 ins. 6 p.m., in 47° 15′ N and 28° W, barometer 29·03 ins. (lowest reading recorded).

(205) 7 p.m., in 47° 15′ N and 30° 30′ W, wind shifted to West-north-west, blowing a hurricane, barometer 28·84 ins.

(152) 5 p.m., heavy gale veering to the Westward. 7 p.m., in 48° 15′ N and 28° 30′ W, blowing a hurricane from West-north-west, barometer 28·61 ins., and beginning to rise as the wind shifted to the Northward.

(62) 3 a.m., barometer 30·15 ins., began to fall. 8 a.m., wind East-south-east and rain falling in torrents. Noon, in 50° 45′ N and 26° 15′ W, barometer 29·33 ins., blowing a whole gale, sky bearing a very threatening appearance. 6 40 p.m., in 50° 45′ N and 26° 30′ W, wind East-north-east, barometer 28·45 ins., its lowest point; soon after the wind lulled down considerably. 7.30 p.m., the barometer began to rise, and at 8 p.m. a regular hurricane burst upon us from North-north-east, rain in torrents, sky black, no horizon, and the whole sea in a boil.

SEPTEMBER 1st.

(129) After a fresh breeze from Westward, at 5 p.m., 31st, in 51° 20′ N and 16° W, wind became light, then came up from South-south-west, barometer 29·70 ins., freshened up rapidly and hauled gradually round by South, barometer falling very rapidly. At 3 a.m., G.M.T., September 1st, in 51° 25′ N and 18° W, blowing hard, wind East-north-east, barometer 28·25 ins., wind hauled round to North gradually and increased in violence, barometer rose steadily. At 7.30 a.m. (G.M.T.), wind blew most violently, after which time it gradually lessened in force, remaining steady in direction for some hours.

(102) 4 a.m., in 50° N and 17° W, the barometer 28·32 ins., wind Easterly, 4, backing to the North-eastward, with very threatening appearance to the Northward. 5.30 a.m., a hurricane struck us from North-north-east, kept ship away to the Southward, when the barometer began to rise rapidly and wind to moderate. 8 a.m., ship in 49° 50′ N and 17° 50′ W (see Chart). The barometer rose 0·5 in. between 8 a.m. and noon.

(60) 0 a.m. (midnight), barometer 28·97 ins., wind South-south-east, 8. 4 a.m., barometer 28·39 ins. 4.30 a.m., in 51° 20′ N and 16° W, wind hauled to N. 5.30 a.m., sudden increase to force 11, direction still North.

(76) 8 a.m., in 47° 50′ N and 14° 30′ W, sudden shift to West-north-west, force 11.

(123) 0 a.m. (midnight), in 48° N and 14° W, strong Southerly gale. 4 a.m., barometer 29·05 ins., hard gale, violent squalls, topsails blew away. 8 a.m., in 48° 15′ N and 12° 35′ W (see Chart), after 8 a.m. the wind increased and blew with irresistible fury, throwing the ship on her beam ends and causing a prodigious sea. Noon, barometer 28·50 ins., still blowing terrifically, ship on her beam ends, sea anchor out. 4 p.m., in about 48° 15′ N and 12° 15′ W, barometer 28·33 ins., sudden shift of wind to West-north-west, and sky cleared and glass began to rise, but at sunset it became overcast again and the wind increased to the fury of a hurricane and the ship was again thrown

on her beam ends, although at the time she only had "goose-winged" main topsail set and was riding to a sea anchor. 9 p.m., dreadful hurricane, wind raging with irresistible fury and a most fearful sea running. At daylight, 2nd, the weather began to improve, and at noon, 2nd, it had considerably moderated and the sea began to go down, barometer 29·30 ins.

(81) 4 a.m., in 49° 15′ N and 12° W, whole gale, barometer falling rapidly. 4 p.m., in 49° 25′ N and 10° 30′ W, wind lulled and veered to West, force 6, barometer 28·29 ins., wind then hauling to North-west and increasing.

(159) 8 a.m., wind flew into South-east, force 6, from West-south-west, 5, in a squall. Noon, South-south-east, 11, barometer 28·93 ins. 3 p.m., in 49° 40′ N and 9° W, barometer 28·39 ins., wind South-south-west, 11, terrific storm and high sea.

(103) 10 p.m., in 51° 30′ N and about 8° W, barometer at lowest, 28·14 ins.

The following are extracts from the Shipping Casualties published in *Lloyds' List*, and supplement the extracts from the ships' logs which immediately precede them. They bear wholly upon the depressions Nos. IV. and V. They are also arranged in order of date, and the extracts from the westernmost vessels are given first each day as far as is practicable.

AUGUST 28th.

NEW YORK, *September 5th.*—All incoming vessels report heavy weather at sea. The British ship *Macedonia* brought yesterday twelve survivors from the wreck of the Swedish barque *David*, abandoned August 31st. She encountered a terrific hurricane off Cape Hatteras, on August 28th, when a succession of mountainous seas swept over her, carrying away everything above deck, together with the captain, the second mate, and five seamen. The barque *Lady Dufferin* reports encountering a similar hurricane, when she lost everything movable from the decks. Despatches from Newfoundland report great disasters among the fishing fleets on the banks, where the storm on the 28th and 29th was the severest ever known. Over thirty vessels are missing, and there are grave fears for their safety.

The *Samuel Skolfield*, American ship, from Calcutta for New York, was abandoned during the night of August 28th, in lat. 36° N, long. 66° W after having experienced a hurricane.

AUGUST 29th.

The schooner *B. J. Willard*, from Philadelphia, encountered a gale August 29th, in lat. 44°, long. 56°. She had mainsail, foresail and two jibs blown away, and high seas swept over the ship from all directions, destroying the boats, smashing the bulwarks, and taking everything movable from the deck; the cabin was flooded and the provisions destroyed; one seaman was swept overboard and drowned; two others were badly injured from being knocked about the deck.

The steamer *Rotterdam*, from Rotterdam, reports:—August 29th, lat. 42° 50′, long. 57° 50′, had a hurricane from South-south-west, lasting 12 hours, with a tremendous heavy sea; carried away all storm sails, tearing away boat covers from off boats.

The steamer *Venetian*, from Liverpool, reports:—August 29th, lat. 41° 20′, long. 62°, encountered a hurricane with terrific seas from South-east veering to West, the centre passing close to the ship; the changes of the wind took three hours: barometer 28·90 ins. at 10 p.m., the gale came on so suddenly we had little or no warning, the barometer commenced rising at midnight.

The ship *Raphael* reports:—August 29th, lat. 38° 30′, long. 63° 30′, had a severe hurricane from South-east, shipped a sea which carried away the binnacle stove skylight and boats, broke spankerboom, and flooded cabin with water. The master and three men were severely injured.

The barque *Lady Dufferin*, from London, reports:—August 29th, lat. 43° 38′, long. 63° 36′, encountered a fearfully violent hurricane, commencing at South-east and ending at North-east, during which the squalls and gusts came in quick succession, and there were fears that everything would be carried away. The sea was one mass of foam, blowing completely over the vessel, and the heavy seas shipped did much damage.

HALIFAX, *August 29th.*—The heaviest storm since the gale in last March prevails here to-night.

The barque *Egeria*, from Hamburg, reports:—August 29th, lat. 40° 10′, long. 67° 10′, had a terrific hurricane from North-east, lasting eight hours; lost some sails, but received no serious damage.

The *Lamport* (s), from Baltimore for London, which put into Halifax September 6th, with machinery disabled, had encountered the gale of August 29th. All the boats were carried away or disabled, part of the bulwarks smashed, and other damages sustained. Of 170 cattle shipped 134 were lost. A number of the crew were badly injured.

The *Buccari*, from New York for Alexandria, was spoken, September 20th, in lat. 38°, long. 13°, by the *Barcelona*, and reported having experienced a cyclone, August 29th, during which she lost two men and sustained important damage.

AUGUST 30th.

The Norwegian barque *Vanadis*, from Sackville, reports having encountered fearful weather on August 30th, off Sable Island, during which Captain Johnsen was washed overboard and drowned. The ship had her decks swept and lost her deckload.

NORTH SYDNEY, C.B., *August 30th.*—A terrible Easterly gale prevailed last night.

The *Amelia*, German ship, from Hamburg, reports:—August 30th, lat. 43°, long. 52°, had a violent storm, during which lost lower foretopsail and everything movable from decks.

AUGUST 31st.

The Norwegian barque *Aljuca*, from Mobile, reports that, on the 31st of August, in lat. 48° N, long. 25° W, vessel encountered a strong gale, and one man was washed overboard and the greater portion of the sails blown away. About one-half of the deck cargo was washed away. Part of the stern and the steering gear were also carried away.

The steamer *Macedonia*, from Marseilles, reports:—August 31st, lat. 37° 30′, long. 65°, at 4.30 p.m. sighted a barque with foretopmast gone and signal of distress flying, bore down for the barque, which proved to be the *David* (Swedish), from Samarang, viâ Batavia, for New York; found the captain, second mate and carpenter had been washed overboard, and crew wished to abandon the vessel.

SEPTEMBER 1st.

BRISTOL.—The *Augusta*, arrived here to-day from Barbadoes, reports:—On September 1st, in lat. 48° N, long. 18° W, was thrown on broadside for several hours, lost 90 feet of topgallant bulwarks, had bulwarks damaged, and everything movable swept overboard; hull much strained.

ANTWERP.—Captain Rogers of the *Cartago Nova* (s), reports that during voyage from Carthagena for this port, on Saturday, September 1st, the ship was hove to for 20 hours, and had 80 feet of bulwarks washed away, port lifeboat, binnacle, railing, and woodwork around the bridge, stoke-hole, ventilators, steam-winch pipe and covering torn from the decks, and other damages. On the 2nd, lat. 48° 10′ N, long. 16° 15′ W, at 6 a.m., a heavy sea broke on board and washed William Mearns, carpenter, of North Shields, overboard, who was drowned; sea running at the time very high.

The *Murciano* steamer, from Baltimore, encountered severe gales between 1st and 2nd, and had one boat smashed, foretopsail yard carried away, and 91 head of cattle lost overboard.

The *Ben Voirlich* steamer, from Odessa, in gale, 1st and 2nd, had cabin companion smashed in, mouldings round stern carried away, cabin filled with water, three boats carried away, and two seamen had their legs broken.

SEPTEMBER 2nd.

MILFORD HAVEN, *September 6th.*—The *Lady Clive* (s) put in last night with the crew of the German barque *Kathinka* on board. The barque was bound from Hamburg for Port Royal, and was abandoned in a sinking condition on the 2nd inst., in lat. 46° 9′ N, long. 9° W. All the crew saved, but no effects. *Lady Clive* (s) lost sails.

BAYONNE, *September 3rd.*—An Italian brigantine, from Bilbao, was totally lost yesterday; part of crew saved.

HAVRE, *September 3rd.*—Lighters Nos. 1, 3, 11, and 24 sank in the outer port during the gale of yesterday.

At Jersey the shipping in the harbour sustained much damage during the gale, some vessels having to be scuttled.

APPLEDORE, *September 2nd.*—Trinity skiff reports a pilot skiff having sunk at Lundy with all hands.

PLYMOUTH, *September 2nd.*—A heavy gale, veering from South-south-east to South-south-west, sprang up yesterday afternoon and continued with unabated fury through the night, with heavy rain, barometer ranging as low as 28·80 ins.

COWES, *September 3rd.*—At 9 a.m. yesterday, a French ketch, in ballast, came ashore at Ladder Chine, near Blackgang. Crew saved. The vessel will be a total wreck.

PORTSMOUTH, *September 2nd.*—It has blown a hard gale all last night and this day from South-south-east to West.

The *Henrich Bjorn*, from Brevig, arrived in the Downs, reports that on September 2nd, about 5 a.m., when off Beachy Head, she saw a barque of about 400 tons register, apparently of English build, capsize and sink.

The *Congella* (s), whilst coming up Channel on Sunday morning about 8 o'clock, in the height of the tremendous gale, when off Beachy Head, distant four miles, saw about a mile off a brigantine with double topsailyards, reefed mainsail, and foresail blown away, and apparently about 150 tons register, suddenly capsize. In about three minutes she righted and went down head foremost, and before our steamer could be got round to her, owing to the gale (wind hurricane force), although every effort was made to do so, could not see wreckage or any of the crew afterwards.

The *Uros*, arrived from New York, reports that on September 2nd, about 15 miles South-west of Beachy Head, observed an iron barque, supposed British, of 600 or 700 register, lying on her beam ends, with topgallant and royal masts cut away. In 10 minutes she was lost sight of and is supposed to have foundered; strong wind and heavy sea running.

DOVER, *September 3rd*.—A terrific gale was experienced here from 2 o'clock yesterday until past midnight from South to South-west. Midday.—The boat for Calais and tidal boat from Folkestone prevented leaving.

MARGATE, *September 2nd*.—A heavy gale has been raging here to-day from South-south-west. Sixty vessels are at anchor in Margate Roads, many of them being large steamers.

FILEY, *September 2nd*.—Three fishing boats broke adrift from anchorage; no lives lost.

WALTON-ON-THE-NAZE, *September 2nd*.—A vessel, apparently a barge, laden with straw, capsized when passing about three miles off. Also a large ship, dismasted, on east end of Gunfleet.

FOWEY, *September 3rd*.—From Saturday noon and throughout the night it blew a heavy gale from about South to South-south-west, with heavy blinding rain. 2nd.—Throughout the day, South-west to West-south-west, strong gale, with heavy rain. Noon, 3rd.—West to West-north-west, fresh, clear. All the vessels in harbour rode the gale out well.

SEPTEMBER 3rd.

MALIN HEAD, *September 3rd*.—A steamship, name unknown, of the Londonderry and Glasgow Steamship Company, is ashore on Inishtrahull Island, off this place.

The steamer *Phœnix*, of Lubeck, foundered 3rd inst., in lat. 48° 35′ N, long. 6° 52′ W; carpenter drowned; remainder of crew saved.

The following extracts from the *Times* will show somewhat the nature of the storm whilst in the vicinity of the British Islands:—

The *Coldra*, British steamer, from England, is reported from San Sebastian to have been totally wrecked in entering Passages. Part of the crew were saved.

A telegram received from Bayonne states that the *Walton* ship has been lost on the rocks at the entrance to Bayonne.

A Bordeaux telegram states that the Steam Navigation Company's steamer *Lapwing* found four shipwrecked fishermen floating on a small raft off that port. Other fishing boats were wrecked with loss of hands.

The Morecambe steamer *Iris* has been totally wrecked on Inishtrahull Island, near the entrance to Lough Foyle. One life is reported lost.

From Ireland we learn that the weather on Saturday and Sunday, September 1st and 2nd, was harsh and stormy, and much damage, it is feared, has been done to the crops. The tide rose to an unusual height, flooding the quays at Wexford and the houses in the lower part of the town, and the sea broke with violence over several places. A yacht broke loose from her moorings in Kingstown Harbour and went to pieces on the rocks near Sandy Cove.

The barque *G. J. Jones*, 312 tons, of Newport, was on Saturday night, September 1st, totally lost off Perran, in Mount's Bay, and 11 out of 13 of the crew and the Falmouth pilot were drowned.

Early on the morning of September 2nd the Norwegian barque *Elise*, from Pablio, dashed ashore under Plymouth Hoe. After parting one anchor after another she struck on the rocks stern first, and then swinging round, broke her back on the ladies' bathing place. She parted in two near the bows. Here the crew of nine had gathered, and the Plymouth lifeboat succeeded in taking them off. In a short time the ship split to pieces.

PLYMOUTH, *September 2nd*.—A fearful South-west gale has raged incessantly for 48 hours off the coasts of the West of England. Near the rocks from the Lizard to Land's End the waves have been running extremely high, and it is feared many of the jagged inlets have been the scenes of wrecks of smaller craft. The telegraph poles near the Land's End were thrown down, and all messages had to be sent from Penzance. Such

a storm could not but cause the greatest danger to all craft coming up the channel. The P. and O. steamship *Parramatta*, on arriving outside Plymouth during the night, determined not to make the land, but to stay until the gale moderated. At Dawlish the sea broke over trains and the traffic was much interrupted. During the gale at Padstow, a sand barge with two men on board was seen working up the river with sails split and shipping heavy seas. A gig was manned, but before it reached her she settled down, and an old man who was at the helm was washed away. The second man was taken off the top of the mast. At Torquay considerable damage was done to the pier, and several yachts and all the boats of the Torquay Rowing Club were smashed. The mail steamer to Scilly was unable to make the usual passage. The sea flooded the promenade at Penzance. Two artillerymen have been drowned at Mount Batten in an attempt to save the paddles in their boat.

The Norwegian barque *Christiana*, of Drammen, bound to Dartmouth, with timber, was wrecked at Chesil Cove, September 2nd. All the crew with the exception of two seamen were saved.

PORTLAND, *September 2nd.*—The gale here destroyed nearly half a mile of the Portland line, and caused a total suspension of traffic. The disaster was fortunately discovered just prior to a train starting from Weymouth, and a catastrophe was thus avoided.

On Sunday afternoon, September 2nd, at Weymouth, a barque was observed in the bay. For more than two hours she tried to get round Portland Bill, but was unable to do so. Her captain then determined to make for Chesil Cove, and run her ashore. The coastguard were in waiting with the rocket apparatus, and almost as soon as the ship struck, the life-line was got on board and eight of the crew saved. Unfortunately, the cook and steward, thinking they could get on shore, as sometimes a receding wave left the beach almost dry, jumped down, one of the men having a lifebuoy on. They had scarcely touched the beach when a wave broke over the ship and carried them out to sea. One was drowned almost immediately, but the other for more than two hours fought with the seas, which broke over him continually.

The steamer *Ajax*, bound from Liverpool for China with passengers and a general cargo, put into Falmouth. She had encountered the full force of the gale, and had the wheel-house washed away and the forward house, forecastle, and lamp-room gutted. The captain was washed overboard and drowned on the north coast. The French schooner *Maria*, of Granville, Captain Roullet, bound from Swansea for Regneville with coals, struck on the Doom Bar, Padstow, and went to pieces. The crew succeeded in safely landing in their own boats.

The *Thetis*, yacht, has been totally wrecked at Bognor.

BRIGHTON, *September 2nd.*—A terrific gale blew along the South Coast during Saturday night (September 1st and 2nd) and continued to-day, increasing in force as the time of the mid-day tide arrived. The waves broke violently on the beach at Brighton, forming a brilliant spectacle. They reached up to the deck of the West Pier. The foreshore at Hove has suffered severely.

EASTBOURNE, *September 2nd.*—The storm here last night and to-day raged with great violence. The waves are described as leaping thirty feet high at half-tide. Part of the East-end of the town was flooded, the new sea-wall works and pier were damaged, and the regatta pavilion was broken up by the sea. The water entered the Marine Drives.

Owing to the heavy gales which had prevailed for forty-eight hours, and continued on September 3rd, there was an extraordinary low tide in the Thames which considerably interfered with the river traffic and caused great inconvenience in the loading and unloading of vessels moored below London Bridge. At 20 minutes to 11 the water had left the whole of the upper river steamboat piers high and dry, and had receded at Lambeth Pier to 20 ft. 8 ins. below Trinity high water mark, being one of the lowest tides on record. Several of the vessels belonging to the London Steamboat Company ran aground in the middle of the river off Vauxhall Pier, while others were blocked in on the Middlesex side. The Middlesex and Surrey shores of the river were visible for a great distance, and in some parts, especially opposite the Victoria and Albert Embankments, people were enabled to walk along the muddy and stony banks in search of anything that was to be found in the shape of coin or other articles. At Woolwich the tide was so low that the traffic was stopped, and several large vessels on either side of the Thames were aground.

There has been a heavy and almost incessant downpour of rain in Anglesey, Carnarvonshire, Flintshire, and Merionethshire. The rivers are consequently greatly swollen, and there are serious apprehensions of floods. Much damage has been done to the crops.

In the Sittingbourne and Faversham fruit and hop-growing district the damage is much more serious even than was supposed on a first inspection. Hundreds of poles of hops are lying upon the ground, and in the gardens in which the string system is adopted immense numbers of strings have been broken. The hops, especially in

exposed plantations, are terribly "cut up," bruised, and battered, and discolouration is setting in to an alarming extent.

The *Rome*, Norwegian barque, of Arendal, from Finland for London, with battens and firewood, stranded on the Gunfleet Sand on Sunday, September 2nd. The crew, 13 in number, were, with the English pilot, landed at Clacton-on-Sea the same evening by the Albert Edward lifeboat. The *Rome* is a vessel of 800 tons register.

Industry, smack, of Lynn, from Goole to Thornham, has foundered off Ingoldinells, Lincoln; crew saved.

The Meteorological Office gave warnings of this storm on the morning of September 1st, and the *New York Herald* also issued the following warning on August 31st:—

"A storm centre is crossing between lat. 40° and 52°; will probably arrive on the British, French, and Norwegian coasts between the 2nd and 4th, South-east to North-west gales. Severe weather on Atlantic north of lat. 35°."

It may be of interest to mention that the steamship *State of Nevada*, bound from the Clyde to New York, met this storm, then having hurricane force, in about 41° N. latitude, and 66° W. longitude, 400 miles to the east of New York, at 8 p.m., August 29th. This vessel reached New York at midnight on 30th, so that a cautionary notice for a storm approaching the shores of the British Islands might with safety have been issued immediately on her arrival, for the storm had then only reached 49° N. and 45° W., and did not arrive on the west coast of Ireland until noon, September 1st; exactly thirty-six hours after the *State of Nevada* reached New York. Details respecting the nature and position of the storm, such as those which could have been furnished by the *State of Nevada*, are wanted to render the *New York Herald* warnings of fuller scientific value. The rapid rate of progress of this gale would necessarily have diminished the time which elapsed between the warning and the occurrence of the gale in our Islands, for its rate of progress was fully double that of ordinary gales which traverse the Atlantic, the average rate having been about forty miles an hour from the American coast to the vicinity of these islands, whereas the usual speed with which storms travel over the Atlantic is certainly below twenty miles an hour.

Professor Loomis, who has devoted much attention to this branch of the subject, has calculated the average velocity of storm-centres on the Atlantic Ocean to be fourteen miles per hour, and has shown the rate of progress to be less over the sea than over either America or Europe. In an article written by me for the *Nautical Magazine* of May, 1881, in which the storm-centres in the North Atlantic for the whole of the year 1879 were dealt with, it is shown that the time occupied by a storm traversing the Atlantic from America to Europe averages five days, the times ranging from three to eight days; and it is further shown that the period of from four to six days for the passage across the Atlantic is likely to prove correct three times out of every four. The average speed of all the storms which crossed the Atlantic during that year was about eighteen miles per hour.

Doubtless, very much has yet to be learnt as to the probable track of a

storm, when even such a disturbance is known to exist; and, although the present is a case in which the depression can be tracked across the Atlantic, it would be a valuable and interesting discussion to investigate for a fairly long and consecutive period the extent to which depressions travel from America to Europe; and further to discover why a comparatively shallow depression should develop into a storm of considerable magnitude, and, on the other hand, why a violent storm apparently travelling in a direct course for our islands should fill up partially, or even wholly, before reaching our shores. The rapid development of this storm as it travelled to the eastwards across the Atlantic is not an uncommon feature—and it has been often noticed that storms exhibit a much lower reading of the barometer on approaching the British Islands than they do when in the neighbourhood of the American coast. It seems probable that an expert in the science of meteorology, stationed somewhere on the Atlantic coast of America, say at New York, with power to board in-bound vessels, might, with a knowledge of the atmospheric conditions as exhibited by the United States War Department Daily Weather Map, often give valuable and timely warning of storms approaching Europe.

The storm which forms the special subject of this Paper does not appear to have had so pronounced a rain area in advance of the storm as has been shown to be usually the case by Mr. Abercromby and others. When over the sea there would appear to have been nearly as frequent entries of rain in the rear as in the front of the storm's path. The rainfall was heavy in parts of the British Islands, but it is difficult to separate the fall for the several parts of the storm area; at the Irish stations the average fall was 1·08 in. from 8 a.m. 1st to 8 a.m. 2nd, and for the same twenty-four hours the fall for the stations in Great Britain, which were all approximately to the front of the storm's path throughout the period, was 0·3 in. The average fall was the same (0·3 in.) for the twenty-four hours from 8 a.m. 2nd to 8 a.m. 3rd, during which time the storm-centre had traversed England and was passing off to the North Sea.

It would be very interesting to know why the speed with which this storm-centre was travelling became so very much less when it reached the coasts of the British Islands than it was whilst over the Atlantic; the average speed over the British Islands varied from thirteen to eigtheen miles per hour, as against forty miles when over the sea; but to whatever cause this may be attributed, it seems highly probable that the process of filling up, which the disturbance underwent whilst traversing these islands, must also be associated with it; and possibly also the more northerly route chosen by the storm-centre.

The severity of the storm may be somewhat estimated from the wreck returns, which show that twenty-two vessels were lost on the coasts of the United Kingdom during the week in which the storm occurred; this number is equal to the total for the four weeks of September, 1882, and four in excess of the total number of wrecks in the corresponding four weeks of September, 1881.

The Charts also show other points of interest beyond the tracing of the

special storm under discussion, and the following brief remarks gathered from a study of them may prove of value.

CHART FOR AUGUST 27TH. (Plate 1.)

An area of low barometric pressure, No. I., was situated to the North of Scotland, the lowest barometer readings having been about 29·5 ins., although the winds over the whole of the United Kingdom felt the influence, yet the force nowhere reached that of a gale.

A low pressure area, No. II., having its centre in about 50° N and 37° 30′ W, with barometer readings as low as 29·4 ins., and accompanied by winds of gale force, was travelling in a North-easterly direction: this was the same depression which caused so much havoc amongst the Newfoundland fishing fleet on August 26th, and the Track Chart (Plate 9) indicates its path of progress from the 24th, when its centre was situated slightly to the North-west of Bermuda, there is evidence that it originated much further to the southward. It was now advancing towards these Islands at the rate of about 850 miles per day. Low pressure area, No. III., was situated over Lower Canada, and a gale was blowing in the Gulf of St. Lawrence.

The advance of the low pressure area No. IV., which is the same disturbance as that which reached the English coast on September 2nd, is just showing itself in the extreme south-western corner of the Chart, and the Track Chart (Plate 9) shows it to have been steadily working up from the Southward since August 24th.

CHART FOR AUGUST 28TH. (Plate 2.)

The low pressure area No. I. has advanced to the east-south-east and is now situated over Sweden, and although the winds nowhere attain the force of a gale yet they are circulating round this depression over the whole of the British Islands as well as over the greater part of Western Europe. Low pressure area No. II. has its centre in about 55° N and 22° W,—the lowest barometer readings shown are 29·7 ins.—wind still maintains the force of a gale, and its rate of progress to the north-eastward (N 62° E) is about 650 miles per day; it is now within about 450 miles of the north-west coast of Ireland, but the Daily Weather Report shows no very evident signs of its approach, the 2 p.m. observations, however, indicate its existence, and the 6 p.m. observations show the centre at that time to be slightly to the north of Ireland. The wind only reached the force of a gale at one or two stations in the British Islands. The low pressure area No. III. has advanced to the east-north-east, about 550 miles in the twenty-four hours—no barometer readings are recorded lower than 29·7 ins., and only one ship records a moderate gale, except in the rear, where the strength of the wind is due to the following high pressure. Full details have already been given of storm-centres Nos. IV and V.

CHART FOR AUGUST 29TH. (Plate 3.)

The low pressure area No. I. has passed off to the eastward, and is not now shown in the limits of the Chart. Low pressure area No. II. is situated

to the west of Denmark, and has travelled to the eastward rather more than 1,000 miles in the last twenty-four hours. It is influencing the circulation of the winds over the whole of Western Europe, but the force of a gale is only reached at one or two stations: this gale was accompanied with but little rain. The low pressure area No. III. has advanced about 725 miles in the last twenty-four hours, and its centre is now situated in about 56° N and 30° W—the wind only attains the force of a gale in the rear of the depression under the influence of the accompanying high pressure. The low pressure areas Nos. IV. and V. have now apparently coalesced. This storm has been dealt with in the earlier part of the paper.

CHART FOR AUGUST 30TH. (Plate 4.)

The low pressure area No. II. has passed away to the north-eastwards altogether beyond the limits of the Chart. The low pressure area No. III. has moved due east, about 600 miles in twenty-four hours; its centre is now in about 56° N and 12° 30′ W; 200 miles to the west of Scotland; its approach, however, was not shown by the Daily Weather Report Stations until 8 a.m. of this date. The wind did not reach the force of a gale in the British Islands, although it did so in the north of France under the influence of a high pressure to the southward. In the rear of the depression a few vessels record a moderate gale. Details respecting low pressure area Nos. IV. and V. have already been given. A low pressure area, No. VI., at present very shallow, and apparently a subsidiary to Nos. IV. and V., is shown in about 33° N and 73° W, it is accompanied by winds of gale force.

CHART FOR AUGUST 31ST. (Plate 5.)

The low pressure area, No. III, has crossed the north of Scotland and is now situated between the Shetlands and Norway; it has travelled about 600 miles in the last twenty-four hours; it is not accompanied by winds of gale force. The low pressure area, Nos. IV. and V., which now has its centre in about 50° N and 37° 30′ W, has already been fully discussed. The low pressure area, No. VI., has advanced about 850 miles in the twenty-four hours to the north-eastwards and its centre is now in about 42° 30′ N and 61° W; it has fairly maintained its relative position with regard to the primary depression (Nos. IV. and V.); it is still accompanied by winds of gale force. A fresh low pressure area, No. VII., has appeared in the South-western corner of the Chart, having its centre in about 32° N and 70° W; it is also accompanied by winds of gale force.

CHART FOR SEPTEMBER 1ST. (Plate 6.)

The low pressure area No. III. has passed beyond the limits of the Chart. That of Nos. IV. and V. has been dealt with in the body of the paper. The low pressure area No. VI. has advanced about 450 miles to the north-eastward, and is situated to the south-east of Newfoundland. Low pressure area No. VII. has advanced about 480 miles to the north-north-eastward, and is now accompanied with more winds of gale force.

CHART FOR SEPTEMBER 2ND. (Plate 7.)

The low pressure area Nos. IV. and V. has continued to advance to the

eastward, full details respecting it having been given in an earlier part of this paper. A subsidiary depression, No. VIII., is seen in about 45° N and 30° 15′ W, and is accompanied by winds of gale force. The Daily Weather Reports for September 4th and 5th seem to indicate that this subsidiary depression, which was formed on the 2nd, preserved its character and maintained the same relative position with regard to the primary disturbance (Nos. IV. and V.) until it passed over the British Islands on the 5th. The Chart for the 3rd, however, does not show evidence of this subsidiary. Low pressure area No. VI. has taken a Northerly route, and is almost beyond the limits of the Chart, at least the limits for which data exist. Low pressure area No. VII. has made but very slight movement to the Northward, and the winds in connection with it do not now reach gale force.

CHART FOR SEPTEMBER 3RD. (Plate 8.)

The low pressure area No. VI. has passed beyond the limits of the Chart, and low pressure area No. VII. has advanced north-north-eastwards, and again has winds of gale force in connection with it. The conditions over the North Atlantic on this day are more quiet than at any previous time for which the daily Charts have been drawn for illustrating this paper. The normal circulation in the Atlantic, under such conditions, round the central area of high barometer, which is of a more or less permanent character, is well shown; as is also the influence of this high pressure area on the winds both of Europe and America; it is clearly on this day the source of the winds of gale force in connection with depressions Nos. IV. and V. over the North Sea and depression No. VII. over Lower Canada.

The following is a list of the vessels whose observations have been used in drawing the Charts for this Paper. The numbers prefixed correspond to those placed at the ends of the respective arrows on the Charts. An asterisk indicates a steamer:—

1. Kansas*	25. Belair*	49. Thingvalla*
2. Indiana*	26. Warwick*	50. Caribbean*
3. Lisbonense*	27. Undine	51. Excelsior
4. Iowa*	28. Ethiopia*	52. Her Majesty
5. Holland*	29. Annie Harris	53. Berkshire
6. Bulgarian*	30. Anchoria*	54. Persian Monarch*
7. Germanic*	31. Habsburg*	55. Cuban*
8. Greece*	32. State of Nevada*	56. Illinois*
9. Flora	33. British Princess*	57. Qvos
10. Elbe*	34. Persian	58. Mataura
11. Egypt*	35. Alice	59. Ludgate Hill*
12. E. J. Spicer	36. Austrian*	60. Samaria*
13. Chancellor*	37. Alaska*	61. Mary Mark
14. Duke of Athol	38. Arizona*	62. Carbis Bay*
15. Ravensdale*	39. Waitangi	63. Lienen
16. Circassia*	40. Jehu	64. Carrie Dingle
17. Bolivia*	41. Quillota	65. Monarch
18. Brinkburn*	42. British Princess	66. Hermes
19. Broomhaugh*	43. Tarnan	67. Sverre
20. British Prince*	44. Congal	68. Thor
21. Furnessia*	45. Germania	69. Hartburn*
22. Gallia*	46. Pudsey Dawson	70. Glenudal
23. Belgravia*	47. Ellerslie	71. Justine Heléne
24. Tikoma	48. Caroline	72. Tower Hill*

73. Lake Winnipeg*
74. Lord Gough*
75. Lord Clive*
76. Mirzapore
77. Mareca
78. Missouri*
79. Oranmore*
80. Ohio*
81. Martha Edmonds
82. Frances
83. Africa*
84. Jorgen Lorentzen
85. Walkyrien
86. City of Asaph
87. Nightingale
88. Creole*
89. Hermanos
90. James Dunn
91. Celtic*
92. Venetian*
93. Bothnia*
94. Devon*
95. Helen Scott
96. Arab
97. Jupiter
98. Vennerne
99. Cortez
100. R. L. T.
101. Hanoverian*
102. England*
103. Republic*
104. Scandinavian*
105. Scythia*
106. State of Georgia*
107. State of Greece*
108. Robert Dickinson*
109. Rialto*
110. Romano*
111. Peruvian*
112. Virginian*
113. Lake Manitoba*
114. Sardinian*
115. State of Nebraska*
116. State of Alabama*
117. Standard*
118. The Queen*
119. Texas*
120. Tartar*
121. Wyoming*
122. Zaandam*
123. Loch Katrine
124. Somerset*
125. State of Indiana*
126. Maiden City
127. Lake Huron*
128. Paulus
129. British Crown*
130. Sarah
131. Wm. Graham
132. Domenico
133. Glenavon*
134. Huntingdon*
135. Helmstedt*
136. Bristol*
137. Concordia*
138. Glide
139. Velox
140. Sophocles
141. Frey
142. Elisabeth
143. Ophir
144. Viola
145. Discoverer*
146. Ontario*
147. Slieve Bloom
148. Mentmore*
149. Souvenir
150. Nestor
151. Waimea
152. France*
153. Freiheit
154. Candahar
155. Florence
156. Euclid
157. Brooklyn City*
158. Erminia
159. Boston City*
160. Manitoban*
161. Cosmo
162. Euripides*
163. Alpheta
164. Genius
165. Budstikken
166. Augur
167. Mathilde
168. Clymene*
169. Inga
170. Candidate
171. Mosser*
172. Opawa
173. Theresina*
174. Dominion*
175. Edna
176. Alf
177. Carita
178. Lady Penrhyn
179. Venice
180. Excelsior, Brixham
181. Goolwa
182. Fulda*
183. Amsterdam
184. Rosa
185. Komandor Svend Föyn
186. Agnes Oswald
187. B. F. Matthews*
188. Alpina
189. Nantes*
190. Nova Scotian*
191. Caspian*
192. Forest Queen
193. Aureola
194. Roslin Castle*
195. Cornwall*
196. Inverdrine
197. Daniel Steinmann*
198. Glen Ville
199. Huano
200. Lady Dufferin
201. Lake Champlain*
202. Mediator*
203. Argo
204. Dora
205. Chrysolite
206. Romano*
207. Emeli
208. Fama
209. Christian
210. Montrose
211. Carl Gustaf
212. Einar Tambarskjaelvar
213. Oscar I.
214. Dagny
215. Melmerby
216. Fanny Atkinson
217. Venezuelan*
218. Loyal
219. Orchid
220. G. M. Carins
221. Kate
222. Minia*
223. Bury St. Edmunds
224. Festina lente
225. Tenedos, H.M.S.
226. Salerno*
227. Louise
228. Unto
229. Norma
230. Wolviston*
231. Frederick Pogge
232. Ansgar
233. Hildegard
234. Othello
235. Craigs
236. Imperator
237. Minerva
238. Camona*
239. Huntingdon*
240. Pavonia*
241. Abyssinia*
242. Grant
243. Daphne
244. Flid
245. Birgette
246. Toronto*
247. Archimedes
248. Traveller

DISCUSSION.

Mr. ABERCROMBY thought that the Society would appreciate the labour involved in the preparation of the paper Mr. Harding had just read, and also the promptness with which such large charts had been compiled. The Atlantic was the natural sphere for investigation by English meteorologists, and therefore any discussion of observations made over that ocean were specially valuable.

He had noticed that the weather in this country, at the time of the storm discussed, was very peculiar. He was staying near Leeds in Yorkshire when the storm passed over these islands, and was so struck by the peculiar character of the weather, that he made a note of it. On his return to London, he compared his observations with the Daily Weather Charts which were redrawn on a large scale, and so was able to explain the remarkable sequence of weather observed. The peculiarity which he noticed was that rain commenced to fall at 4.45 p.m. on the afternoon of September 1st, and continued for twenty-eight hours with a falling barometer. At 6 p.m., September 2nd, the mercury began to rise, but the rain continued for twenty-three hours more, with much worse weather generally than while the barometer was falling. The sky also never assumed the typical aspect which is due to the rear of a cyclone, but remained dirty and misty, like that associated with the front of a cyclone. It was only on the second day after the mercury began to rise that the *cumulus* and showers characteristic of the rear of a cyclone made their appearance. His examination of this apparently anomalous weather showed that the explanation was very simple. The first twenty-eight hours of rain, with a falling barometer, were due to the front of a primary cyclone, and so far represented the usual sequence of weather in such cases. The first two hours of rain after the mercury began to rise were due to the cyclone filling up so rapidly, that although the trough of the cyclone was two hours distant from Leeds, still the rise from filling up overbalanced the fall due to the approach of the trough. These two hours of rain were therefore really due to the front of the cyclone. The details were as follows:—At 6 p.m. September 2nd, the trough of the cyclone was two hours distant from Leeds, on the supposition that the cyclone moved at a uniform rate. If there had been no filling up, from the motion of the observed isobars, the barometer should have fallen 0·02 in. at Leeds during the two hours from 6 to 8 p.m., owing to the progress of the cyclone. On the other hand, if there had been no advance of the cyclone, but only filling up, the mercury should have risen 0·05 in. from that cause. Therefore the balance of rise over fall should have been 0·03 in. The measurements from his own instruments gave a rise of only 0·02 in., but in an irregular cyclone like this one, it was very difficult to decide precisely what the lowest point would have been at any station. The remaining twenty-one hours of rain, with a rising barometer, and generally worse weather, together with the characteristic sky of the front of a cyclone, were due to the formation of a secondary in rear of the primary; so that although the mercury was rising owing to the passage and filling up of the primary, still Leeds was, during the whole of September 3rd; exposed to the influence of the front of a secondary, with its characteristic dirty weather. The wind was stronger after the barometer began to rise, because the gradients were steeper in rear of the primary than they were in most portions of the front. By the fourth day the secondary had passed away, and then the typical weather of the rear of a cyclone was experienced. This was a very interesting example of the manner in which apparent anomalies in the indications of the barometer might be reduced to general principles.

Lieut.-Gen. STRACHEY wished it to be understood that the Meteorological Council, while they willingly gave Mr. Harding permission to use the material available in the Meteorological Office for the preparation of his paper, were in no way responsible for the conclusions at which he had arrived. It was a well-known fact, that depressions were habitually crossing the Atlantic, and passing to the North of the permanent high pressure area in that ocean; but, under what circumstances such depressions developed into severe storms before they reached the British Islands, was a question which as yet remained unanswered. The storm which Mr. Harding had described, was an indisputable example of a disturbance of this nature, and therefore, was well worthy of special notice. He hoped that the more complete study of the atmospheric condition of the North Atlantic for the whole year, from August 1882 to August 1883, on which the Meteorological Office was now engaged, might serve to throw light on this subject, which was one likely to be of much practical importance in relation to the forecast of weather in the British Isles.

Capt. TOYNBEE said that the paper was a valuable record of facts. This and similar work had abundantly shown that storms crossed the Atlantic from West to East. It was also known that the general disposition of barometrical pressure over the Atlantic and Western Europe affected the tracks of these storms;

and it was believed that telegrams from New York to London, giving the positions on the Atlantic of the various storms which had been met with by steamers arriving from Europe, together with the known disposition of pressure over Western Europe since those storms were met with, would be useful data for improving forecasts. But what was chiefly needed was some great mind to tell how these storms were originated, and what caused their advance along a given track? Also, what caused subsidiaries to form and to travel round the main disturbances?

Mr. BUDD remarked, that he was on Dartmoor when this storm reached these islands, and on the night preceding its arrival he witnessed a most wonderful sunset, clearly indicative of storm conditions in the atmosphere, within an appreciable distance of the points of observation.

Mr. C. HARDING in reply said that the subsidiary depression formed in the rear of the primary disturbance, first shown on the Chart for September 2nd in 45° N and 30° W, and which seemed to have preserved its relative position with regard to the primary until it passed over the British Islands on September 5th, might have had some influence in checking the rate of progress of the primary. Observations had been utilised from between 200 and 300 ships, and the quality of the material was excellent. He was in the South of England when the storm was raging, and had noticed that while before the gale the foliage was beautiful, after it had subsided the trees presented a singed appearance.

ON THE INFLUENCE OF THE MOON ON THE HEIGHT OF THE BAROMETER WITHIN THE TROPICS. By ROBERT LAWSON, Inspector General of Hospitals. (Abstract.)

[Read November 21st, 1883.]

THE author, having referred to the conclusions arrived at by Sir Edward Sabine, from discussions of the St. Helena observations, and by Captain Elliott from the Singapore observations, that the altitude of the moon affected slightly the barometric readings, proceeds to discuss observations made at Ascension, September 1st, 1863, to August 30th, 1865; St. Helena, January 6th, 1843, to December 23rd, 1846; and Sierra Leone, January 1st, 1849, to December 30th, 1850, with the view of tracing the effect of changes in the moon's declination upon the barometric height.

He shows that, at Ascension, when the moon's declination was passing from about its northernmost point to its southernmost, the mean height of the barometer was ·016 in. higher than when it moved in the opposite direction, and the change from the higher to the lower position and *vice versâ* was abrupt. At St. Helena the difference was less, being ·007 in., whilst at Sierra Leone it amounted to ·0126 in. In all these cases the curves representing the results exhibit secondary maxima and minima.

The author also inquires into the influence of the moon at new and full; and also at perigee and apogee, upon barometric readings. In the first case he contrasts the mean height for eight days about the time of new moon with that of eight days about full moon; the results obtained show small fluctuations not exceeding ·015in., and the curves from the three stations but slightly resemble each other in character.

With regard to the third and final research the author states that the materials at his disposal were insufficient for the purpose, and that a series of observations extending over eighteen years would be required for a proper solution of the question of lunar influence.

ON THE EXPLANATION OF CERTAIN WEATHER PROGNOSTICS. By THE HON. RALPH ABERCROMBY, F.R.Met.Soc.

[Read December 19th, 1883.]

IN a former paper read before this Society, the author, in conjunction with Mr. Marriott, explained a large number of prognostics, by grouping them round different shapes of isobars, such as cyclones, &c. with which they are associated. But there are a large number of well known prognostics, which cannot be conveniently so grouped, and the object of this paper is to explain some of the latter kind, classifying them by the objects observed, such as the sun, stars, &c.

The groups he proposes to take now, are :—1. Diurnal; 2. Sun, moon, stars; 3. Sky; 4. Rain, snow, hail; 5. Wells, underground springs, &c.

These he will endeavour to explain in a uniform manner, by first giving the prognostic with any variations of its reading, which often throw light on its full significance; then its explanation, referring as much as possible to synoptic charts, and indicating the conditions of its success, as well as of its failure, and finally sum up by a general estimate of the value of the prognostic.

In a few cases he will bring in illustrations of foreign prognostics, sometimes to show how some depend on the general principles of meteorology, and sometimes to show the common origin of others. Though many will thus be seen to have a very wide-spread value, it must particularly be noted that some are very local to our Islands, and that what may portend rain in one part of the world, may indicate fine weather in another.

Hitherto the great reproach cast on the science of prognostics has been that though the explanation would occasionally be given why it should succeed, no reason could be assigned why it should sometimes fail. No reason could either be given why rain for instance should in one instance be indicated by one prognostic, and in another instance by another, or why all rain should not be preceded by the same prognostics.

For example, many rains are preceded by halo, but rain often falls without any such appearance, and halos are frequently seen, without any rain following.

Many of these difficulties the author hopes now to remove by the method of investigation adopted.

1. DIURNAL PROGNOSTICS.

By diurnal prognostics are meant those which relate to weather changes in their relation to the time of day. They may be conveniently grouped into three classes.

a. Those connected with the appearance of the rising or setting sun.
b. Those connected with the occurrence of rain at different hours.
c. Those relating to the wind at different hours.

a. SUNRISE AND SUNSET.

"A high dawn indicates wind;
A low dawn, fair weather,"

A 'high dawn' is when the first indications of daylight are seen above a bank of clouds. A 'low dawn' is when the day breaks on or near the horizon, the first streaks of light being very low down.

In fine weather, mist is usually formed over the sea during the night, which gives the appearance of a bank of cloud on the horizon, over which the first touch of dawn is seen.

In windy weather, hard *stratus* cloud is usually formed, so that dawn would first be seen either on the horizon, or on the under surface of a cloud; while in rainy weather, the sky would be so dirty that no well defined dawn would be observed at all. Clouds and mist are, however, so capricious and variable that though this prognostic is sometimes good, it frequently fails.

"The evening red and the morning grey,
Is the sign of a bright and cheery day.
The evening grey and the morning red,
Put on your hat, or you'll wet your head."

"Sky red in the morning
Is a sailor's sure warning,
Sky red at night
Is the sailor's delight."

These are but a few of the endless variations of this prognostic, which is known all over Europe.

"In England when the red at sunrise rests on the horizon, it is a sign of rain; but when the red flushes up into the sky, it is a sign of a fine day."

The red at sunrise may be a mere glare and short lived. In fact, if it hold out till the sun is fairly above the horizon, many look for a fine day.

"A bright or glary morning is seldom followed by a fine day."

"Cloudy mornings turn to clear evenings."

"If the sky at sunrise is cloudy, and the clouds soon disperse, certain fine weather will follow."

"At sunset a rosy sky presages fine weather;
A dark (or *Indian*) red sky, rain;
A sickly looking greenish hue, wind and rain;
A bright yellow, wind;
A pale yellow, rain."

"When the golden yellow at sunset is seen last on the plain, and the hills are dark, bad weather may be expected; but when the yellow mounts, and is last seen on the hills, then fine weather is likely to follow."

"At sunset, red opposite the sun is a sign of rain."

These may all very conveniently be taken together. Commencing with sunrise. In a typical period of fine anticyclone weather, there is usually so much radiation mist, that the sun does not break through at once, and thus rises grey. If the sky was dirty from a cyclone front, the morning would likewise be grey, but it would also be watery, and could not practically be mistaken.

Sometimes, however, there are portions of anticyclones which are so windy,

that radiation mists cannot form. The sky is then cloudless, and the red which must precede dawn, flushes up into the sky, and indicates a fine day. Under these circumstances, the red may last till the sun is fairly above the horizon.

But now, if from a cyclone of such moderate intensity as only to form cloud, or, from the hard *stratus* of straight isobars, or the *cirro-stratus* of an approaching thunderstorm, there are no morning mists, but *stratus* or *cumulus* clouds of any kind, then the red of dawn will be reflected on them, the sunrise will be red, and the colour will rest on the horizon.

Now it is known from general causes that neither of these conditions are those of settled fine weather. The intensity of any cyclone will always increase with the day, and thus develop rain instead of only cloud; while with straight isobars, a cyclone will almost certainly form soon, so that in either case the prognostic would hold good.

At first sight, this may seem to oppose the saying quoted above, that "cloudy mornings turn to clear evenings." The explanation depends on the kind of cloud. The cloud to which the saying applies, is a radiation cloud, which forms in some cases either instead of ground mist, or else later on in the day. In practice this cloud can hardly be mistaken, but a test which rarely fails, may be mentioned here.

In a radiation mist or cloud, if the sun can be seen shining dimly through it, the sun's outline is clear, and has the appearance of being seen through smoked glass. If the sun, on the contrary, is seen through a cyclone cloud, its outline is blurred into the well-known watery look of such skies. Thus this prognostic is allied to that of grey mornings.

The converse French saying that "weather which is fine during the night, lasts but a short time after daylight," and the British prognostic that "bright glary mornings are seldom followed by a fine day," hold good when the clear sky is associated with the extreme rear of a cyclone, with a wedge, or with straight isobars. On the other hand, it sometimes fails in the windy portion of an anticyclone. In this case, however, a practised observer rarely fails to detect the difference between the kinds of glare or brightness, though it is difficult to express the appearance in words.

Coming now to sunsets, with which the public are more familiar than with sunrises, the points for consideration are as at sunrise, first, the extremes of sunset in anticyclone and cyclone weather, and then the intermediate forms.

In a dry cloudless anticyclone, as the sun approaches the horizon, the light first begins to get yellow, after some time the yellow grows into orange, which quickly passes into red on the Western portion of the horizon only. Still later, the red disappears, and in this country, there is, sometimes, an after-glow of yellowish grey. This kind of red, therefore, is associated with settled fine weather. If, on the contrary, the sky is grey and dirty from a cyclone front, there is no development of colour at all, "The sun goes pale to bed," as the popular saying runs. Then, of course, as the cyclone comes on, rain will certainly fall.

By carefully watching the transitional conditions of sky and cloud between

these two extremes, the author has found that a sky not quite so opaque and dirty as to form grey, will develop a pale yellow at sunset. This, then, is the sky formed in an earlier portion of a cyclone than that which would produce a pale sunset, but equally presages rain.

With a sky still too dirty to form red, but somewhat harder than the above, a bright yellow is developed. Why this should appear before wind rather than rain, seems to depend on the general principle that a hard sky is windy, and a soft one rainy. These hard skies are usually found at the extreme Southerly edge of a cyclone, that is, in the cloudy portion of it, outside the rain area. There the gradients are frequently steep enough to give a great deal of wind, but little or no rain. Neither of these yellow skies is often followed by any red, but all becomes grey and dark.

The sickly looking greenish hue which is sometimes the precursor of wind and rain, is one which the author has so rarely observed, that he is unable to say much about it. In Scotland during winter a green look of the sky, at any hour, is said to be a sign of snow, and this the author has verified. As wind and rain together are, however, practically almost always cyclonic, there can be little doubt that the sickly green represents the sun setting in the sky, which belongs to some portion of a cyclone, probably in front of that which would form pale yellow.

But now, if the sun sets in a sky free from haze, but more or less covered with cloud, then a brilliant sunset with every successive mixture of blue, yellow, and red will be observed. The details vary almost indefinitely.

The cause of the great mixture of colours is this. When the sun sets in a cloudless sky, the sequence of colour, blue, green, yellow, orange, red,—is zoned as it were from the zenith overhead down to the horizon, like the colours of a spectrum. But if there are two or three layers of cloud at different altitudes, the same cloud may receive light by reflection of two or more colours from different sources. Then much more complex colours are produced. For sky colouring there must be used a different conception to that of the painter's idea of three primary colours. To the meteorologist, every colour in a spectrum which has a definite wave length must be considered as primary physically. Then when two or more of these are mixed, a series of what may be called physiological colours follows, as they represent the effect on the eye of several superimposed waves. In practice, the most important case of this kind occurs with green skies, some of which appear due to pure absorption, others, to a mixture of blue and yellow. The colour resulting from such a mixture, can be seen in any spectrum formed by a diffraction grating where the higher orders of spectra overlap.

Prof. Piazzi Smyth is the only authority the author is acquainted with who has given attention to colours as produced by mixed spectra, though he takes no notice of the great amount of light, which his investigations throw on sunset tints. In his *Madeira Spectroscopic*, 1881-1882, he gives a most instructive diagram. 1st, of nineteen pure spectrum colours; 2nd, of nine colours produced by mixing more or less, two spectrum tints not naturally adjacent to, or blending into each other. These double mixed tints are mostly

shades of maroon, crimson, lilac, and purple; all well-known sunset colours. 3rd, of nine colours produced by mixing in various proportions, three pure spectrum tints, also, not naturally adjacent to, or blending into each other. These treble mixtures are mostly browns, impure yellows, and olive greens, also common sunset colours. If any of these mixed tints could be passed through a spectroscope, they would be resolved into their primary tints. One difference must, however, be noted between spectrum and sky colours. The former are produced by unequal refraction, the latter partially by unequal absorption. Whence these last can never be so pure as the first.

A considerable amount of obscurity still remains in regard to these absorption colours. Tyndall has shown that the usual blue of the sky is due to the scattering rays of light, when they pass through an atmosphere laden with very small impurities, such as fine dust, or minute particles of condensed vapour. The ordinary theory of sunset colours is that atmospheric impurities begin by absorbing the blue rays first. If blue is taken out of a spectrum the remaining mixture ought to be more orange than it really is. Another point frequently to be observed is that the reflected light from a soft cloud is not the same colour as the incident light. For instance, a yellow sunset reflected from locomotive steam or soft *cumulus*, will be more brown than the light on the horizon. This points to absorption by reflection, as well as by transmission; but it is impossible to separate what is due to absorption, and what to mixture by reflection from different parts of the sky. Fortunately though there is much uncertainty as to the full theory of absorption, the explanation of sunset prognostics is not affected thereby.

Now applying these principles to the explanation of prognostics, it will be seen that a dark or Indian red, or angry red sky is not the pure more rosy red, such as is observable in anticyclone skies, but mixed with the reflection from some kind of cloud, or produced by the presence of condensed vapour in some form. If clouds are low down, especially soft detached *cumulus*, then the red is reflected opposite the sun. Often by mixture of reflections the author has observed these *cumuli* coloured various shades of brown, and also that they are signs of rain. Curiously enough they do not appear in any known prognostic.

In an earlier stage of the sunset, while the light is yet yellow with a cloudless sky, and in a hilly country, the fading yellow will creep up the hills, and be last seen on their tops.

With some kinds of cloud, especially *stratus*, the last glow of light may be through a chink in the sky, after which the sun will be hidden by the cloud, and unable to light up the hill-tops. Then the golden yellow is last seen on the plain.

The explanation of all these prognostics therefore depends on the presence of a certain amount of detached cloud in an otherwise bright sky. The variations which may occur, are practically endless, but in a general way it may be said, that though none of those colours could occur in the front of a cyclone, they are none of them associated with settled fine weather. Besides the rosy red of a cloudless sky, there are many instances of red sunsets at

the rear or southerly edge of a cyclone, which are followed by fine days, owing to the onward passage of the cyclone, and the absence of a new one.

But there are also more numerous instances, especially when the *cumuli* are soft and low, where it is almost certain that a fresh cyclone will arrive, or more probably form within twelve hours. Then the various prognostics just detailed will hold good.

The United States Signal Officers observe sunrise and sunset tints, at almost all their stations, to assist in the preparation of forecasts from their synoptic charts. They find that about eighty-two per cent. of the sky colours are followed by the weather they are popularly supposed to indicate. It is doubtful whether in Great Britain these are anything like so trustworthy.

The author has thus shown independently of all theory, that the explanation of sunset tints depends on the manner in which the different kinds of cloud and sky found in different portions of cyclones, or other shapes of isobars, analyse by absorption the oblique rays of a setting sun. In fact, with a little practice, an observer can say to himself at any time of day, if the sun set in the sky now visible, it would take such and such colours.

The author has made a large number of observations with a spectroscope on these colours, but without any decisive result. One point however is quite clear, assuming that the darkness of the so-called rain band on the red side of the D line is a rough measure of the amount of water vapour in the air, no direct connection can be traced between its amount and any particular colour. That uncondensed vapour does affect absorption is undoubted; but it is perfectly certain from observation, that not only the size of the particles of condensed vapour floating in the air as cloud or mist, but also their physical condition whether ice or water, has a far more important *rôle* in the production of absorption tints.

Such being the case, it is obvious that the spectroscope ought to be able to distinguish between the quality of light passed through a mass of condensed vapour when frozen, and when in a liquid condition. In practice the author has been unable to detect any such difference, but he believes that it undoubtedly exists. Captain Abney has discovered by means of photography, that the so-called "alpha" band between C and D and half the "*a*" line are coincident with the absorption bands of a moderate thickness of water. He has also found that ice gives no lines or absorption bands, but there is still much obscurity about the subject. The technical difficulties in the way of discovering such a difference are, that a small spectroscope has not sufficient dispersion to count many lines; while a more powerful one does not pass enough light from the feeble reflection of most clouds to give a visible spectrum. The suggestion of putting a collecting lens in front of the slit is not as useful as would appear at first sight. There is always so much diffused light in the air that there is no certainty that only the light from a particular source enters the slit.

Though no absorption tint has yet been clearly traced to frozen vapour, there are strong grounds for believing that the green sky before snow, and the lurid sky of hail and thunder are due to the presence of ice particles.

From the optical phenomena of halos and coronæ, it can often be known whether a cloud is ice or water, therefore for colour observations, at present the eye is a far better guide to the condition of any sky than the spectroscope.

"A rainbow in the morning,
Sailors take warning;
A rainbow at night,
Is the sailor's delight."

The explanation of this is found in what is known as the diurnal variation of weather, in conjunction with the fact that most of our bad weather disappears in the east.

Thus, if the weather was showery so as to give a bow in the morning, it is known from the nature of diurnal variation, that the wind, rain, and general severity of the weather will increase till about 2 p.m. and then grow finer towards evening, so that the first portion of the prognostic is good.

If on the contrary a bow was seen in the evening, diurnal variation will naturally make a drier night, and by next day the cyclone—with the rear of which the showers were probably associated, will most likely have passed away, and will leave fine weather behind it.

Sometimes, however, a cyclone may go on slowly and so produce bad weather next day; at other times when one cyclone has passed away, another may follow very quickly. In either of these cases the prognostic would fail, but on the whole however, it is a tolerably good one.

The following examples will illustrate both the success and failure of an evening rainbow, and may be taken as a fair example of the whole method here adopted for explaining prognostics. In fig. 1 is a chart at 6 p.m., June 4th, 1882. At 6.15 p.m., a rainbow was visible in London, but the night was bright and fine, and would so far have been suitable for a man who was watching sheep-folds. The next day was overcast with a little rain, as might be expected from the straight isobars seen in fig. 2, which are given for 8 a.m. the next morning. In fig. 3 in the chart for 6 p.m., June 9th, 1882, a well-defined cyclone is shown covering England. At 7 p.m., a rainbow was seen in London, but the night and next day were very showery. The chart, fig. 4, for 8 a.m. next day shows that the cyclone was moving to S.E., but so slowly that its influence was felt all day, and in this case the prognostic totally failed.

b. Hours of Rain.

A class of prognostics has now to be considered which can unfortunately only partially be explained. In this country the diurnal variation of rain is so complicated that it has at present only been incompletely worked out. The reason of the difficulty is that rain falls under a variety of different conditions, as for instance in cyclones, in secondaries, and sometimes even in anticyclones. Each of these has a different diurnal variation of intensity which would develop rain at different hours. Then another source of

FIG. 1.

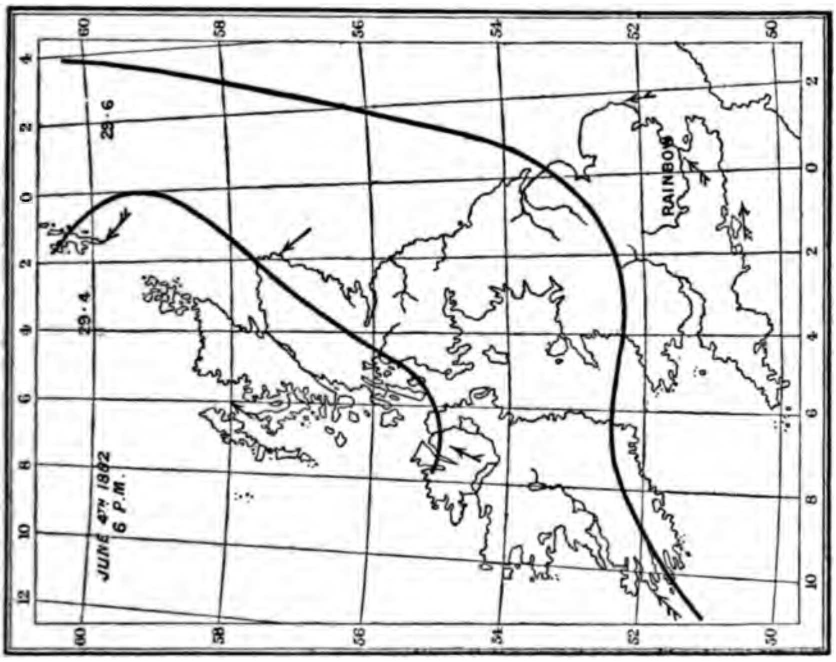
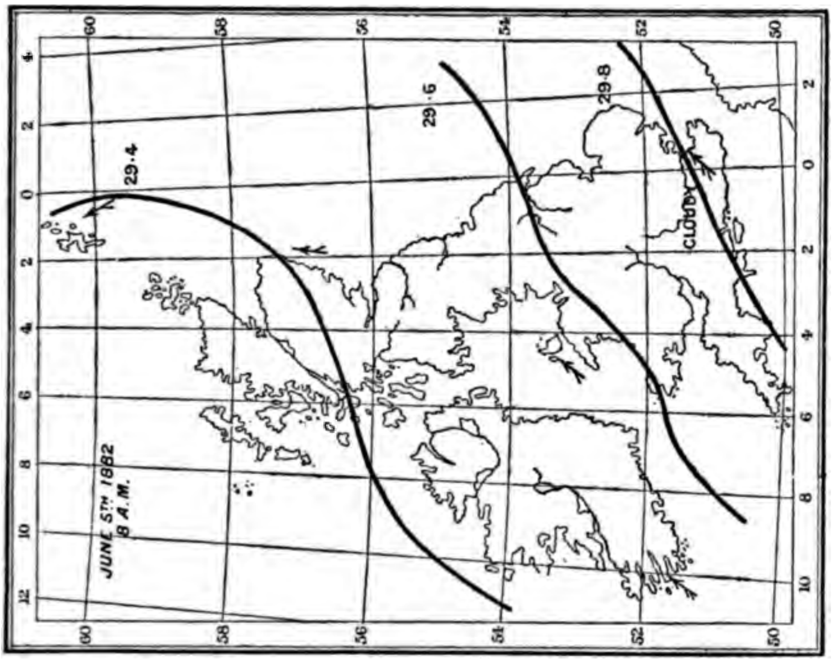

JUNE 4TH 1882
6 P.M.
29·6
29·4
RAINBOW

FIG. 2.


JUNE 5TH 1882
8 A.M.
29.4
29·6
29·8
CLOUDY


JUNE 9TH 1882
6 P M
29·7
29·5
29·3
THUNDER
29·7

Fig. 3.

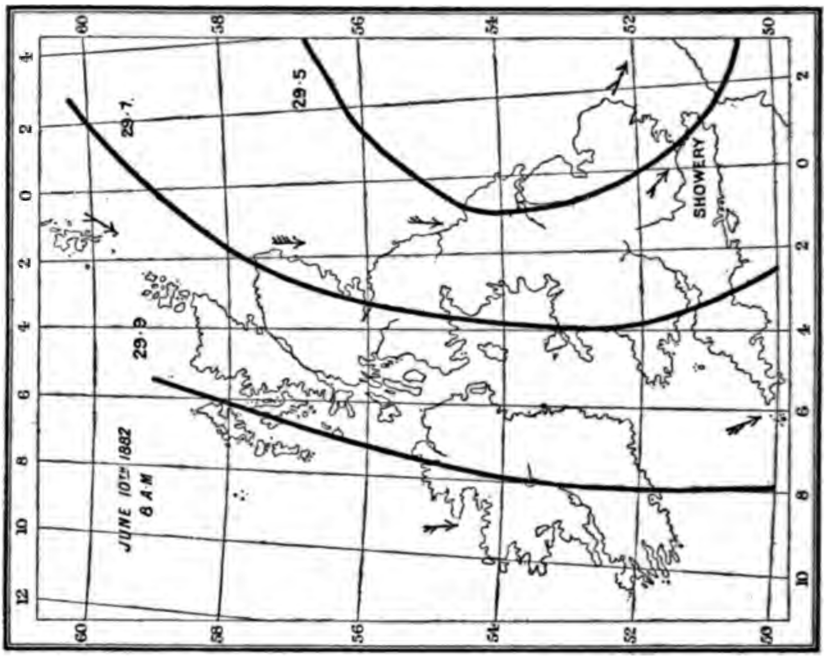

JUNE 10TH 1882
8 A M
29·7
29·5
29·9
SHOWERY

Fig. 4.

complication comes in, from the tendency of secondaries and thunderstorms to form at particular hours—and still another, from the tendency of existing cyclones in certain types to press in from the Atlantic during the early hours of the morning.

The almost insuperable difficulty of working out the question thoroughly, arises from the changeable nature of the British climate, and the limited area of observation, which make it nearly impossible ever to trace any existing cyclone or other isobaric shape for twenty-four hours consecutively. Secondaries and thunderstorms also rarely live for twenty-four hours.

It is obvious from the above considerations that it is impossible to use the mean or statistical curve of diurnal frequency of rain, as this merely gives the actual relative frequency of rainfall. No deduction can be made from it as to the diurnal period of rain in any particular shapes of isobars. Any predominant variation may doubtless be reflected in the mean curve, but the effect of each source of variation may differ in various parts of the country.

For instance, there is reason to believe that the principal variation of rain in a cyclone consists of a very marked increase of rain frequency in the middle of the day; and that the tendency of secondaries and some kinds of thunderstorms is to form about sunrise, and to a less degree about sunset; and that during the persistence of the Southerly[1] type of weather, cyclones appear to move in from the Atlantic with increased intensity during the night. Whence in some parts of the country the mean curve of frequency has a principal maximum during the day from cyclones, with smaller morning and evening maxima, probably from secondaries. In others, the author believes the secondaries override the cyclone maximum; while in the West Coasts, where the Southerly night rains are more powerful, the principal maximum occurs during the night. It is doubtless possible to find a station where these three sources would be either equal, or would nearly balance each other, and there the curve of frequency would present no particular feature.

In Great Britain, the type of weather changes every few weeks, so that it is very difficult to arrive at the variation of each type; but by going to the tropics, where there are only two or three changes of type in a year, the foregoing principles are more easily verified.

For instance, at Calcutta Mr. H. F. Blanford[2] finds that the weather is divided into three seasons. The rains, June to October, when the frequency curve begins to rise directly after midnight to a small maximum about 6 a.m., and small minimum about 8 a,m. Then the frequency rises rapidly to its principal maximum at 2 p.m., and then falls rapidly to the principal minimum about 1 a.m. The mode of the formation of the rain-cloud of the Summer Monsoon is essentially *cumulus*.

In the hot season, March to May, the diurnal epoch of minimum is not very distinctly indicated, but would appear to occur about sunrise.

[1] For details of this type see *Quarterly Journal*, Vol. IX. p. 3.
[2] *Asiatic Soc. Bengal*, Vol. XLVIII. Part II. 1879.

There is, however, little variation from midnight up to 9 or 10 a.m.; and after this, only a slow rise up to 2 p.m., when the increase becomes more rapid. About two hours before sunset, there is a sudden rise of about fifty per cent., and the hour of maximum rain frequency occurs between 7 and 8 p.m. Compared, however, with the maximum of the rainy season, it is very small. This very striking feature of the hot season is due to evening storms, known as North-Westers, which are closely analogous to the thunderstorms of the European summer. They are so called because they commonly originate in the North-west; and are probably connected with the diurnal variation of wind near the coast.

Lastly, the cold season from November to February. In this, falls of rain are pretty evenly distributed throughout the day, with a decided diminution during the two or three hours before and after midnight. When these are all combined into a yearly curve, the result is a curve which gives the true variation of no season. In this case, as the rainy season curve is very pronounced, and that of the two other seasons much less marked, the annual curve differs but little from that of the rainy season, though some of the minor flexures are altered. Under other conditions the mean annual curve might be very different from that of any one season.

These points shall now be considered in a little more detail, and the prognostics which appear to depend on them for their explanation indicated. In an ordinary cyclone, besides the great increase of rain during the day, already mentioned, there is a remarkable series of smaller variations, some of them obviously connected with the diurnal variation of the barometer. In cyclones, a wet or cloudy morning often has a short break about 10 a.m.; the weather then becomes worse, but has a marked tendency to break again about 4 p.m. In anticyclones the diurnal variation of cloud is altogether different. The cyclone variation affords an explanation of the following curious prognostic, which is widely believed in the North:—

> "There are what are called good and bad hours of clearing. If the weather begin to improve about noon, or 3 p.m., it may be expected to continue better; but if it clear at 11 a.m. or 2 p.m, the improvement is only temporary."

This means, that if the weather improve about noon, in spite of natural diurnal increase, the cyclone is probably passing off; and if the improvement should take place at 3 p.m., the gain will continue, either from diurnal diminution of a not very intense cyclone, or from the passage of the cyclone. On the other hand, the 11 a.m. clearing has been already seen to be only short lived, but the author cannot explain why a clearing about 2 p.m. should not hold.

Another saying is:—

> "If rain do not clear off by 4 p.m. it may be expected to continue some time."

If the rain does not clear about 4 p.m., in spite of diurnal decrease, it shows that the cyclone is either very intense, or that the rainy portion of it is just passing over the observer, and in both cases the rain will therefore probably last some time. Practically those two prognostics are trustworthy.

A somewhat allied saying is :—

"If a change of weather occur when the sun or moon is crossing the meridian, it is for 12 hours at least."

On the lunar portion of this the author can say nothing. Even in this variable climate the greater non-diurnal changes generally last at least twelve hours, and the prognostic may sometimes hold good, but it does not seem a valuable one.

With respect to the nature and origin of the morning rains, which are so common in this country and many parts of Europe, it is certain that they are not purely cyclonic. In many instances they are associated with the formation of small secondaries ; while on the sea coast, they are probably often complicated by the local influences of land and sea breezes. The author is unable to say whether there is any diurnal variation in a true cyclone between the hours of midnight and 8 a.m. for want of personal observation. The following are prognostics referring to this class of rain :—

"If it begin to rain an hour or two before sunrising, it is likely to be fair before noon, and so continue that day; but if the rain begin an hour or two after sunrising, it is likely to rain all that day, except the rainbow be seen before it rains."

"Rain at seven,
Fair at eleven.
Rain at eight,
Fair late."

"Rain before seven,
Fair before eleven."

The Czechs and Poles say :—

"Morning rain and women's tears are soon over."

But that this is a principle which does not hold all over the world is certain, for in the North of Italy the people fear early rain and say :—

"If the rain fall on the dew, it will continue to fall throughout the day."

These prognostics are, on the whole, tolerably trustworthy, though subject to frequent failure.

Lastly, with regard to rains due to the nature of the Southerly type of weather, in which, for some reason, cyclones come in from the Atlantic with greatest intensity during the night time. The difference between this and ordinary cyclone diurnal variation is, that in a cyclone the increased rainfall is not associated with any change of gradient. With the Southerly type, on the contrary, the gradients are usually steeper by night than by day. This sequence of a wet, stormy night, frequently with a peculiar class of sheet lightning or thunder in the early morning, clearing about mid-day, and coming on wet again after dark, is one of the most striking features of the winter weather on our Western Coasts. From the nature of the cyclones of the Southerly type, which are arrested by a persistent area of high pressure

over Northern and Central Europe, the rain in them is often heavy. Hence the meaning of the following prognostics, as well as the limited conditions under which they would hold good:—

"The weather usually clears at noon when a Southerly wind is blowing."

"If it rain at midnight with a South wind, it will generally last above twelve hours."

"Midnight rains
Make drowned fens"—*Lincolnshire.*

c. Diurnal Wind.

The ordinary features of diurnal wind variation in this country are simple. For all shapes of isobars, more or less, the velocity of the wind rises and falls with the sun, as an addition to the amount of wind due to the gradient.

As regards direction, the tendency is to veer a little with the sun and back again during the night.

In a former paper the Author and Mr. Marriott explained some prognostics relating to the veering of the wind in fine weather.[1]

The only other diurnal prognostic which the author has been able to find is:—

"An honest man and a Nor-west wind generally go to sleep together."

This is a common saying, and implies that if the wind is from the Nor-west in the early part of the day, it will veer or fall in the evening. It is common also in Iceland. The Westing appears to be important at northern stations, for in Orkney the saying is:—

"The West wind is a gentleman and goes to bed."

This manifestly refers to the diurnal fall of the wind towards evening. It is doubtful how far the Westing is important generally. Ley has found the diurnal character of East and West winds at Stonyhurst to be practically identical. There is a type of East wind, however, which comes on strongest at night.

Sun, Moon, and Stars.

"Much twinkling of the stars is a sign of rain."

"Sailors sometimes say, that when the stars want snuffing bad weather may be expected."

This prognostic almost explains itself. Its origin seems to be that in unsettled weather the atmosphere gets irregularly composed of strata differing in temperature and moisture, so that a ray of light is irregularly refracted, thus giving excessive twinkling. In a blue sky, with detached clouds, it will frequently be observed that as a cloud approaches a star, the twinkle increases, doubtless owing to the vapour brought up by the cloud.

Of course, cases of broken weather settling down are not uncommon, and then the prognostic would fail, but on the whole it is a good one.

"When during a frost very few stars are seen, rain may be expected."

[1] *Quarterly Journal*, Vol. IX. p. 41.

This refers to the first symptoms of the air growing thick and turbid as a cyclone approaches. It is, however, a little uncertain, especially in low-lying situations, as a radiation fog beginning to form would also obscure the stars and then the prognostic would fail.

"When stars appear with a small circle of light round them, rain may be expected."

This is seen during the same conditions of cloud or vapour, which give rise to a soft-looking moon; and would not be observed with the vapour of a radiation mist or stratus. The prognostic therefore has the same explanation and value as that referring to a pale, watery moon, and is, on the whole, tolerably trustworthy.

"A pale moon is a sign of rain, a red moon of wind, and a white silvery moon of fine weather."

A pale moon refers to a white watery look, which has already been explained as preceding a cyclone and rain. A red moon refers to a rosy tinted circle of light called a "corona," to distinguish it from a halo—which is found when the moon shines through a hard, well-defined cloud, such as forms in rear of a cyclone, or with straight isobars. In either case the immediate portent is for wind, rather than rain.

A white moon refers to a clear, silvery look of the moon in fine, dry, anti-cyclonic weather, which ordinarily may be expected to continue for a few days.

This is a good prognostic, and was originally collected by Aratus; translated into Latin by Virgil, and probably transported into Europe by the monkish rhyme:—

"Pallida luna pluit, rubicunda flat, alba serena."

"When the sun or moon seems to wander through the sky, a storm is at no great distance."

This refers to the appearance of the sun or moon seen through driving clouds, at a considerable altitude, the idea of motion being transferred from the sky to the luminary. The phenomenon occurs only in wild, unsettled weather, and the prognostic is therefore a good one.

"Far burr, near rain."

A "burr" is a circle round the moon. In common parlance there are two distinct phenomena mixed up under this common name. First, the true halos or circles of light, distant either 12½°, 23° or 46° from the moon. These are formed by refraction through frozen particles, and, as already explained, are formed in front of cyclones, and presage rain.

Secondly, smaller circles, often two or three close together, formed from 2° and 5° from the moon, which are properly called "coronæ." These are due to refraction through globules of water, and the smaller the globules the nearer the circle is to the moon.

Clouds which give rise to coronæ are rarely found, except in rear of a cyclone, or in some form of quiet cloud, and in any case small globules are

further from rain than larger ones. Whence, whether a distant circle is really either a halo or a corona, the nearer the circle the farther the rain is likely to be. This is a good prognostic.

3. Sky.

"Clear to the South will drown the ploughman."

"A blue bore in the South will drown the ploughman and his plough."

These are evidently variations of the same saying, as is also probably "Clear in the South beguiled the cadger."

The author has never heard this applied in practice, but it probably refers to an opening of blue sky to the South, while clouds are banking up in the North, with a Northerly wind.

Under these circumstances heavy showers or "plouts of rain" may be expected, and so the prognostic would sometimes hold good.

"In winter, when the sky about mid-day has a greenish appearance to the East or North-east, snow and frost are expected."

This refers to the blue of a clear sky assuming a somewhat greenish tint while the sun is relatively high, and is much more common in Scotland than in England. It is usually associated with some cloud on the horizon, and appears to be connected with the lurid yellowish light often given by frozen clouds, but this cannot be put forward as more than a suggestion. This is one of the cases where it is difficult to say whether the green is a primary colour or a mixture of lurid yellow and natural blue sky. Anyhow, this is a common and trustworthy prognostic.

"A bright appearance of the sky to the North is a sign of frost."

This refers to the sky in the early part of the night, during a winter anticyclone. On such occasions, the horizon is usually misty towards the South, and the direction of the setting sun, while to Northwards the sky is almost always brighter to a marked degree. It is, therefore, a sign of settled weather, which in winter is always accompanied by frost; but is practically a prognostic of small value.

4. Rain, Snow, Hail.

"Rain with a South-east wind is expected to last for some time."

This prognostic means that if in this country rain set in with a South-east wind, it may be expected to last longer than rain with a Southerly or Westerly wind. The greater portion of British rain falls with cyclones moving freely towards the East, and in them, as a rule, there is not much South-east wind. Sometimes, however, when the intensity is very great, there is a strong South-east gale in front of such a cyclone, and then the prognostic fails.

There is a not uncommon type of weather, which may be called the Easterly type, in which the presence of a persistent anticyclone over Scandi-

navia prevents the free passage of cyclones coming in from the Atlantic; they are then arrested in their course, and brood over Great Britain for a day or two without making much eastward progress. Under these circumstances a South-east wind is strongly developed, and the rainy portion of the cyclone never moving on, the rain which belongs to it continues without intermission. The prognostic then holds good, but is, for the reason abovementioned, subject to frequent failure.

"Short slight showers during dry weather are called a hardening of the drought."

The author has never heard this saying applied practically, but it seems to suggest the slight rain which sometimes occurs in a well-defined anticyclone. This rain is due to the formation of a small short-lived secondary, and is not associated with any tendency of the anticyclone to break up.

If this is the case, continued dry weather would be indicated, and the prognostic fully justified.

"When after a snow shower, the sky clears up quickly, but is again overcome with another shower, this is said to be a 'feeding storm.'"

In such a case the air always feels cold. The forms of the flakes of snow are pretty correct indications of the amount of the fall to be expected. When they are broad and large, and fall slowly, there will not be much, and the probability is that a thaw will soon follow. Should the flakes be specular, and fall very fast and thick, then a heavy fall, or a "lying storm" may be expected, and this last sort of fall is always accompanied by a firm breeze of wind from North-east to South-east.

The wording of this saying is self-explanatory. The whole owes its value to the fact that a long spell of cold weather, which would make snow lie, is usually associated with a North-east or East wind. A spell of these winds often begins with showers, and the dryness associated with them makes the snow flakes fine or specular, so that they fall fast.

Snow with large broad flakes, falling slowly, is usually associated with the cold West or North-west winds in rear of a cyclone, which rarely last long. Exceptions to this saying frequently occur in the endless phases of the conflict between cyclones coming in from the Atlantic and Scandinavian anticyclone, but still it is a tolerably good prognostic.

"Fresh snow,
Fresh cold."

The idea meant to be conveyed by this saying is, that if during a period of cold weather fresh snow falls, it is the prelude of continued cold weather, not of a thaw.

The explanation depends on the principle that most weather comes in persistent spells, associated with persistent types of pressure distribution. In this country long frosts occur, with both of the so-called Northerly or Easterly types, and this saying holds good when it happens during persistent spells of either of them. On the other hand, an incoming cyclone of the Easterly type, which gives fresh snow, sometimes passes so far to the East,

that Westerly winds and warmer weather set in later, and then the prognostic fails. On the whole, however, it is a good one, especially in the North of England and in Scotland.[1]

"Hail
Brings frost in the tail."

This may be conveniently considered with the allied saying,

"Hail after long continued rain, indicates a clearing up."

The latter holds good when, after the driving rain of a cyclone front, the weather begins to break into squalls with hail, either during or after the passage of the "trough." It is thus symptomatic of the rear of a cyclone, and, therefore, of a clearing up at any season of the year.

Then as to frost following in winter. Hail is more likely than rain to fall in rear of a cyclone when the pressure is rather high to the Westward of Great Britain, in that case the cyclone is usually followed by a large wedge, which in winter would be associated with a white frost of short duration. On one occasion the author observed hail associated with some small secondaries which accompanied the replacement of the Westerly by the Easterly type of weather in the month of January. The frost which followed was then of longer duration. On the whole these prognostics are tolerably good, the latter being the best.

5. Wells, Springs, Underground.

"In deep wells, the level of the water sometimes rises before rain, or the surface is agitated, and the water discoloured. They also frequently discharge large volumes of air."

"Springs often flow more rapidly before rain (when none has fallen locally), or become slightly discoloured."

"In the collieries about Dysart, and in those of other districts in Scotland, it is thought by the miners, that before a storm of wind a sound not unlike that of a bag-pipe, or the buzz of a bee, comes from the mineral, and that previous to a fall of rain the sound is more subdued."

"Before wind and rain, it is also said, that the black damp extinguishing the lights is observed at the bottom of ironstone pits, and through the waste."

"In Midlothian the miners think that approaching changes of the weather are preceded by an increased flow of water, and the issue of gases, and foul air from the crevices; and when very bad weather is at hand, these last escape with a characteristic sound like the buzz of insects."

These prognostics are doubtless due to the release of compressed air, contained in the fissures of the coal or rock, by the diminution of barometric pressure which always precedes cyclone rain.

First, as to the increased depth of water in wells. Mr. Baldwin Latham

[1] Full details of weather types and their nature will be found in a paper by the author, "On certain types of British Weather," *Quarterly Journal*, Vol. IX. p. 1.

has gauged some deep wells in the chalk near Croydon, and finds that where there was a large amount of water held by capillarity in the strata above the water-line, at that period of the year when the wells became sensitive and the flow from the strata was sluggish, that a fall in the barometer coincides with a rise in the water-line, and that under conditions of high barometric pressure the water-line was lowered.

Percolating gauges also gave similar evidence, for after percolation had ceased, and the filter was apparently dry, a rapid fall of the barometer occurring, a small quantity of water passed from the percolating gauges. The conclusion arrived at was that atmospheric pressure exercises a marked influence upon the escape of water from springs.

Then as to the escape of air. Mr. A. Strahan, F.G.S., has investigated many instances in this country. He finds that in certain cases some wells maintain an active and permanent circulation, and that currents alternately enter or issue from fissures in the sides of the wells. These currents are not due to the evolution of gas by chemical action in the rock or on the water, but the changes in the direction of the current coincide with changes in the movement of the barometer, being outwards with a falling pressure and inwards when the barometer is rising. Such wells are called "blowing wells," and from their extreme sensitiveness to changes of atmospheric pressure give useful indications of the approach of bad weather. Their warnings have been rendered audible by fixing horns or whistles in an air-tight covering, in such a way as to sound readily to the outward current, or to give a different note for an outward or inward movement of the air. As an example of the quantity of air which may be released, Mr. T. Fairley has measured the discharge from a well near Northallerton, and found that a fall of the barometer of 0·26 in. was accompanied by an outflow of 83,900 cubic ft. of air, and by an application of Boyle's law it was calculated that the total capacity of the air-retaining cavities must amount to nearly 10,000,000 cubic ft.

In some wells, with a rapid change of the barometer before rain, the water in the well becomes agitated and slightly discoloured. This is doubtless due to the escape of air from fissures below the level of the water in the well. In most cases the air in blowing wells issues from cavities above, but near the surface of the water.

Another prognostic which is explained by these properties of fissures is the common remark that before bad weather drains smell worse than usual. In fact, every network of covered drains and every covered cesspool, where special provision is not made for ventilation, constitutes a natural blowing well, and as Mr. Strahan points out, with a bad system of ventilation, sewer gas may be forced into a house by every fall of the barometer.

With regard to the effect of atmospheric pressure on the escape of fire-damp from coal seams. Coal is a rock, subject to jointing; seams are broken by faults, and for some distance from the main fracture are traversed by joints and smaller shifts resulting from the general strain. In fiery mines, as Mr. Strahan says, on every side is heard the monotonous hissing or bubbling of the escaping gas, frequently accompanied by the deeper note

of a "blower," or one of those larger channels often observed in connection with faults. The gas is given off as a product of slow decomposition taking place in the coal. While the movement of gas in a blower differs from that of the air in a sandstone fissure, in being always in one direction, namely, outwards, it is at the same time evident that the same cause which induces an outward current in a well would also cause an increase in the outward current from the coal. The increase would be proportional to the capacity of the fissure. A fall in the barometer from 30 ins. to 29 ins., for example, would cause $\frac{1}{30}$th of the body of gas stored in the fissures to be added to the ordinary outflow. A similar argument would apply to an increase of black damp before rain. The liability to explosion in collieries with a diminishing pressure has long been a subject of observation.

Messrs. Scott & Galloway have subjected the colliery explosions in Great Britain to a most searching inquiry, and they find a striking connection between the occurrence of explosions and either a rapid fall in the barometric pressure or a sudden rise of temperature. For instance, in the year 1871, out of 207 explosions (58 of them fatal), 113 or 55 per cent. were due to the state of the atmospheric pressure; 30 or 10 per cent. to the temperature; while 55, or 26 per cent., were not accounted for by either of these agencies.[1]

All these prognostics depend on cyclone rain, and fail for other conditions of precipitation, such as in secondaries, where there is heavy rain without any fall of the barometer. When they are observed, however, they are usually trustworthy.

[In his former paper on Prognostics, the author only explained the sayings which are associated with primary cyclones, but as in this paper the subject of secondary cyclones is frequently alluded to, a few remarks on them may be useful. A secondary cyclone is shown on a synoptic chart by a loop or bend in one of the isobars. In the centre of this there is heavy rain, surrounded by a narrow ring of cloud; no where are steep gradients to be found, and the centre is usually perfectly calm. As the secondary passes over any station, the blue sky first grows dirty, then heavy rain sets in suddenly, with little or no wind, and a stationary barometer. After a time the rain ceases, and the sky soon becomes bright again. Thus in explaining prognostics we have to deal with two distinct kinds of rain: rain from a primary cyclone, associated with wind and a falling barometer, and rain from a secondary associated with calm, and a stationary barometer. In the foregoing paper it has abundantly been shown how many apparent anomalies in the use of prognostics are explained by attending to this distinction of the two kinds of British rainfall. No notice has been taken in the paper of the influence of dust in producing sky colours, for though it is well-known that in tropical countries sand and dust storms give rise to very peculiar colouring, the author has had no opportunity of personally investigating these. —*Note added December* 1883.]

[1] *Quarterly Journal*, Vol. I. p. 240.

PRELIMINARY INQUIRY INTO THE CAUSES OF THE VARIATIONS IN THE READINGS OF BLACK-BULB THERMOMETERS *in Vacuo*. By G. M. WHIPPLE, B.Sc., F.R.Met.Soc., F.R.A.S., Superintendent of the Kew Observatory, Richmond.

[Read December 19th, 1883.]

WHEN the question, "What instruments should be employed for determining the intensity of solar radiation, and in what way can the comparability of the results obtained be insured?" came before the Leipzic Conference in 1872, the want of accordance between the different instruments used to measure it was generally admitted, while Dr. Jelinek submitted that English physicists might be requested to institute experiments, and to report upon the subject. At the subsequent discussion on the Leipzic Programme which took place at the Meeting of this Society, on the 16th of April 1873,[1] a similar opinion as to the uncertainty of this class of observation was expressed, and I am stated to have said, that at Kew it had been decided to have nothing to do with black-bulb thermometers.

Since the date of this discussion, descriptions have been given before the Society of improvements in the instruments designed both by Mr. J. Hicks and Messrs. Negretti & Zambra; whilst the Rev. Fenwick Stow and Mr. Blanford having both devoted a considerable amount of time and trouble in endeavours to utilise the solar-radiation thermometer, decided success has attended their labours.

Both have, however, observed the large differences in the results given by these instruments, and have attempted to correct the readings to an arbitrary standard.

Mr. Stow says[2], "Little or no value is to be attached to the actual readings of these thermometers (that is, blackened bulb maximum thermometers *in vacuo*, freely exposed to sun and air at the height of at least four feet) taken alone. No thermometer when placed in the sun's rays shows the temperature of any other object correctly, and the solar thermometer is not intended to do this. In this paper only the amount of solar radiation, that is, the excess of the reading of a solar thermometer above that of an ordinary maximum thermometer placed in a double louvred screen, is dealt with. To have quoted the actual readings would only have occupied valuable space. I may mention, however, that the solar thermometer, when freely exposed, seldom reads above 140° in this country; and 154° is, I think, the highest temperature registered in the five years.

"The instruments used by my observers have all been compared directly or indirectly with the original instrument (the first made with the stem blackened), which I use as a standard. The comparison is made by exposing the instruments to be compared to the sun's rays for a few weeks side by side,

[1] *Quarterly Journal*, Vol. I. p. 226.
[2] *Quarterly Journal*, Vol. II. p. 206.

and noting the readings both on cloudless and other days." The corrections thus obtained, with the names of the stations and observers, were then given.

Mr. Blanford, in his *Meteorology of India* for 1879, states with reference to the solar radiation observations taken there, "All the instruments in use during the past year have been compared, directly or indirectly, with an arbitrary standard instrument of the same construction (Casella, No. 9174), by thirty readings or more, taken when the compared instruments and the standard were exposed, under similar conditions, to the sun's rays; and the mean difference of the readings thus ascertained has been applied as a correction to all recorded readings of the former. In some cases this correction amounts to as much as 15°, and no registers can be regarded as comparable which have not been subjected to this precautionary correction."

Owing to the labours of these gentlemen and others the thermometer has gradually grown in popular estimation, and this, together with the printing of readings of these instruments, has tended to create a demand for their comparison. In order to satisfy this demand, the opposition maintained at the Kew Observatory with regard to these instruments was withdrawn, and four instruments of different makers' patterns were put up side by side on a frame and a series of observations commenced. The great hail storm of the 3rd of August, 1879, destroyed three of the thermometers. Since then the readings of the survivor alone have been published, and having taken it as an arbitrary standard of reference, from time to time other observers' instruments have been compared with it and tables of correction supplied. Many of these instruments were verified at Kew previous to their being sealed in jackets, and yet there have been large differences in the readings after they were encased. It was also found that the differences varied with the temperatures, and that the constant corrections assumed and employed by Stow and Blanford do not quite meet the case.

With a view to ascertain the cause of these variations, I have, in accordance with Dr. Jelinek's suggestion, entered upon a course of investigations, the preliminary results of which are now submitted to the Society.

I have here to thank Messrs. Negretti & Zambra, who have generously constructed the required instruments in accordance with my instructions free of cost to the Observatory, and the Kew Committee for permission to make and discuss the observations.

My experiments were arranged with the view of ascertaining how far observed discordances are due to variations in the amount of lamp black with which the bulbs are coated, one of the sources of irregularity pointed out by Mr. Scott in his *Elementary Meteorology*, p. 55.

Six maximum thermometers, as nearly as possible uniform in size, were accordingly selected by the makers and sent down to Kew for verification, the scale errors up to 140° in no case exceeding 0°·3. They then had their bulbs coated with lamp black, one pair receiving a single coat each, a second pair two coats, and the remaining pair three coats, and were inserted into their jackets, which were all blown with bulbs 2½ ins. in diameter from the same glass tubing, so that they should be uniform in thickness.

After being heated to 200° and exhausted to a very high degree by means of a mercurial air-pump, they were sealed hermetically, the thermometers being retained in position in the jacket by brass clips, so as to avoid the exudation of moisture into the vacuum which takes place when corks are used for packing.

The thermometers, then, being returned to Kew, were there placed side by side, the bulbs being 4½ ins. apart, on a horizontal wooden frame, 4 ft. above the surface of the grass of the Observatory lawn, 120 ft. away from the building, and freely exposed to the air and sun on all sides. The Kew Reference thermometer, Hicks No. 6, bulb 0·46 in. in diameter, jacket bulb 2¼ ins. in diameter, and a spare thermometer of similar construction, were also placed on the same frame.

The thermometers were read and set daily at 10 a.m. from September 9th to November 18th, 1882. During the winter the observations were suspended, the readings being of little use at that season. On February 7th, 1883, a second series was commenced, which continued without intermission up to August 31st, 1883.

On comparing the readings with the corresponding readings of the Kew Standard great differences were observed and also great irregularities. The extreme variations from the Reference Thermometer were as follows:—

No. 14866	... 11°	No. 19838	... 9°
„ 19836	... 6°	„ 19839	... 13°
„ 19837	... 11°	„ 19840	... 11°

Arranging the readings of the thermometers in numerical order, the following were found to be the mean corrections at the different temperatures:—

TABLE I.

Temperature of Reference Thermometer.	No. of Thermometer.					
	14866	19836	19837	19838	19839	19840
° °	°	°	°	°	°	°
50 to 59	+0·1	+0·7	+1·5	+1·2	+1·9	+1·8
60 „ 69	+0·9	+1·0	+2·5	+1·9	+2·6	+3·0
70 „ 79	+1·0	+1·6	+3·4	+2·6	+3·3	+3·8
80 „ 89	+0·5	+0·3	+3·9	+3·2	+3·3	+4·3
90 „ 99	—0·2	+0·5	+2·6	+3·2	+4·0	+4·5
100 „ 109	—0·1	+0·7	+5·9	+3·9	+5·6	+6·1
110 „ 119	+0·2	+0·7	+6·5	+4·2	+5·7	+6·6
120 „ 129	—0·1	+0·9	+6·6	+4·4	+6·6	+6·7
130 „ 141	—0·3	+1·5	+7·1	+4·9	+7·0	+6·8
Mean	+0·2	+0·9	+4·4	+3·3	+4·4	+4·8

From the above table it will be seen that in all cases, with the exception of No. 14866, there is a tendency for the correction to increase as the temperature rises. In order to see to what extent this behaviour is due to the amount of blackening on the bulb the corrections were combined in pairs according to the number of coatings the bulb had received, with the following results:—

TABLE II.

Mean Temperature of Reference Thermometer.	Thermometer Bulbs having				
	1 Coating.	2 Coatings.		3 Coatings.	
	19840 & 19839	19837 & 19836	Diff.	14866 & 19838	Diff.
°	°	°	°	°	°
55	+1·8	+1·1	0·7	+0·6	0·5
65	+2·8	+1·8	1·0	+1·4	0·4
75	+3·5	+2·5	1·0	+1·8	0·7
85	+3·8	+2·1	1·7	+1·8	0·3
95	+4·3	+1·5	2·8	+1·5	0·0
105	+5·8	+3·3	2·5	+1·9	1·4
115	+6·1	+3·6	2·5	+2·2	1·4
125	+6·6	+3·7	2·9	+2·1	1·6
135	+6·9	+4·3	2·6	+2·3	2·0
Mean	+4·6	+2·7	1·9	+1·7	1·0

These results, represented in Fig. 1, show distinctly that the effect of an increased coating is to raise the temperature, but in diminishing ratio the effect of the third coating being only one half that of the second.

Fig. 1

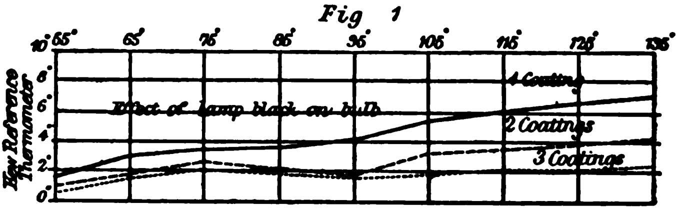
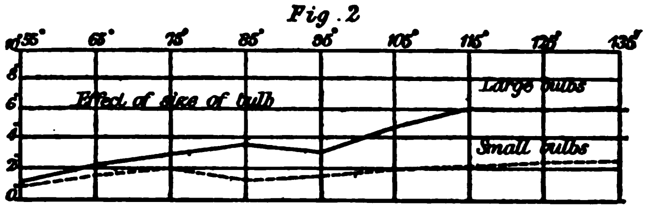


Fig. 2



An examination of Table I., however, shows that although the mean values are affected as above, yet the individual corrections exhibit discrepancies, and for a time I was unable to detect the cause of such variations, but ultimately was led to attribute them to the size of the bulbs or jackets. The latter were easily measured by callipers, and found to be exactly of a size. On measuring, however, the diameters of the thermometer bulbs by the cathetometer they were found to vary slightly, although designed by the glass blower to be of the same dimensions.

The true values are as follow:—

KEW REFERENCE THERMOMETER, No. 6—0·46 in.

		In.			In.
No. 14866	=	0·54	No. 19838	=	0·49
„ 19836	=	0·58	„ 19839	=	0·58
„ 19837	=	0·50	„ 19840	=	0·49

It will at once be seen that they arrange themselves into two groups, large and small bulbs, the mean diameter of Nos. 14866, 19836 and 19839 being 0·583 in., and of the remaining three 0·498 in.

Fortunately, each group contains the three differently coated instruments, and so in order to examine the effect of size of bulb upon the readings, the following table was formed :—

TABLE III.

Corrections at	Large Bulbs.	Small Bulbs.	Difference.
° 55	° +0·9	° +1·5	° 0·6
65	+1·5	+2·5	1·0
75	+2·0	+3·3	1·3
85	+1·4	+3·8	2·4
95	+1·4	+3·4	2·0
105	+2·1	+5·3	3·2
115	+2·2	+5·8	3·6
125	+2·4	+5·9	3·5
135	+2·7	+6·3	3·6
Mean ..	+1·8	+4·2	2·4

These results indicate that the size of the thermometer bulb is a most important factor in the case of this instrument, a difference of 0·04 in. in a half inch bulb, or a difference of only 8 per cent. causing the mean correction of the lesser bulb thermometer to be more than doubled.

Mr. Stow, in the paper already quoted, having stated that the only proper way of dealing with black bulb thermometers was to take the excess of the reading above the ordinary maximum in shade as the amount of solar radiation, and discuss that; I have accordingly treated these observations after his manner. Obtaining the maximum value from the thermograms in order that the period for which the value is assigned may be the same in both instruments, the following table of corrections will serve to reduce the observed solar radiation with each instrument, to that of the Kew Reference Thermometer, Hicks No. 6 :—

TABLE IV.

Correction for Radiation of	No. of Thermometer.					
	14866.	19836.	19837.	19838.	19839.	19840.
°	°	°	°	°	°	°
10	+0·5	+0·9	+2·0	+1·6	+2·0	+2·2
20	+1·1	+1·4	+3·4	+3·0	+2·4	+4·1
30	+0·5	+1·2	+4·0	+3·2	+3·7	+4·4
35	+0·1	+1·2	+4·7	+3·1	+4·1	+4·8
40	—1·1	—0·2	+4·5	+2·8	+3·7	+4·4
45	+0·1	+0·6	+5·3	+3·6	+4·7	+5·5
50	—0·2	+0·4	+5·9	+4·0	+5·0	+5·9
55	—0·1	+1·1	+6·6	+4·4	+6·6	+6·8
60	—0·2	+1·3	+6·9	+4·5	+6·7	+6·9
65	+0·3	+1·9	+7·9	+5·9	+9·5	+7·8

The above values grouped in pairs as in Table II. show a similar behaviour with regard to the amount of black over the bulbs being as follows :—

TABLE V.

Correction for Radiation of	Thermometer Bulbs having				
	1 Coating.	2 Coatings.	Diff.	3 Coatings.	Diff.
Means of	19840 & 19839.	19837 & 19836.		19838 & 14866.	
°	°	°	°	°	°
10	+2·1	+1·5	0·5	+1·1	0·4
20	+3·3	+2·4	0·9	+2·1	0·3
30	+4·1	+2·6	1·5	+1·9	0·7
35	+4·5	+3·0	1·5	+1·6	1·4
40	+4·1	+2·2	1·9	+0·9	1·3
45	+5·1	+3·0	2·1	+1·9	1·1
50	+5·5	+3·2	2·3	+1·9	1·3
55	+6·7	+3·9	2·8	+2·2	1·7
60	+6·8	+4·1	2·7	+2·2	1·9
65	+8·7	+4·9	3·8	+3·1	1·8
Mean	+5·1	+3·1	2·0	+1·9	1·2

Fig. 3

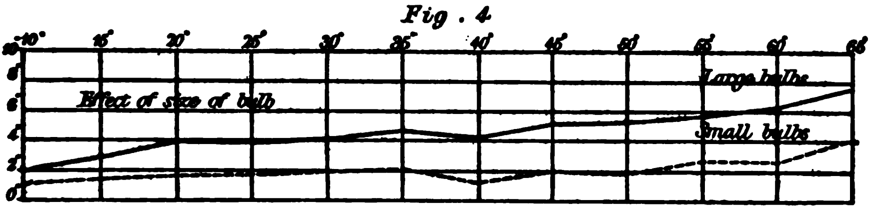
The values are plotted in Fig. 3, and indicate the effect to be precisely similar to that already found, and in like manner if arranged according to size of bulb, as under :—

TABLE VI.

Correction for	Large Bulbs.	Small Bulbs.	Difference.
°	°	°	°
10	+1·1	+1·9	0·8
20	+1·6	+3·5	1·9
30	+1·8	+3·9	2·1
35	+1·8	+4·2	2·4
40	+0·8	+3·9	3·1
45	+1·8	+4·8	3·0
50	+1·7	+5·3	3·6
55	+2·5	+5·9	3·4
60	+2·6	+6·1	3·5
65	+3·9	+7·2	3·3
Mean	+2·0	+4·7	2·7

The curve in Fig. 4 shows that the effect of size of bulb upon radiation is similar to that upon temperature, causing an increasing difference with increased radiation.

Fig. 4



As differences were observed even at low temperatures, it appeared just possible that they might in some measure be due to the fact investigated by Mr. B. Loewy,[1] that an error was produced by the exhaustion of the jacket surrounding the thermometer. This, however, was disproved by comparing two of the thermometers which differed to the greatest extent, in hot water maintained for a long while at a temperature of 140°. At that point the difference between their readings in the water was only 0°·5, whilst when heated by the solar rays to the same extent one read 7°·8 lower than the other.

All the curves exhibit slight departures from regularity, but these are due to a paucity of observations at certain temperatures. They are, however, sufficient to show the nature of the causes affecting black bulb thermometer observations, and would indicate the necessity of exacting from instrument makers a rigid adherence to a standard size of bulb, and a definite amount of coating, as well as a constant state of exhaustion and standard size of jacket.

As to those thermometers at present in use, I think the Fellows will agree

[1] *Proceedings of the Royal Society*, Vol. XVII. p. 319.

with me that in order to utilise the results obtained already, each instrument should undergo a somewhat lengthened comparison, with an adopted standard of reference, in order that its readings might be rendered comparable with others, and that publication of such observations should be suspended until this is done.

Messrs. Negretti and Zambra having kindly volunteered to construct other additional thermometers for me, I hope to be able at some future date to lay before the Society further results bearing upon the important question of the measurement of solar radiation.

Report on the Phenological Observations for 1883. By the Rev. T. A. Preston, M.A., F.R.Met.Soc.

[Read December 19th, 1883.]

The number of observers remains exactly the same, though there are considerable changes in the staff itself. The losses are at Maker, Totnes, Cullompton, Downside, Hoddesdon, Ware, Bradenham, Banbury, Malvern, Chester, Kearsley Moor, and Pomeroy; and to these may be added Isleworth, the observer there having too many engagements to allow of her sending any more returns. On the other hand, fresh stations have been secured at Royston, Hitchin, Hodsock, Macclesfield, Carlisle, and seven other places, but the returns from these latter, as well as from about twelve or fourteen of the old stations, are very meagre; still there is a decided gain upon the whole. Some of the new stations are in the Northern part of England, and the observers generally are scattered more evenly over the country, though many more would be very desirable.

The request for specimens has been better attended to; still some extraordinary dates have been sent in, and in several cases it seems almost certain that the observer has noted the wrong plant. Mistakes of this kind, it must be admitted, have been far less frequent than usual among the specimens sent in, but in other cases there is nothing left but to reject the entry.

The following is the list of observers, made up into two sets, according to the number of observations recorded.

1. Babbacombe	Devon	E. E. Glyde.*
2. Westward Ho	Devon	H. A. Evans.*
3. Tiverton	Devon	Miss M. E. Gill.*
4. Wincanton	Somerset	W. Galpin.
5. Salisbury	Wilts.	W. Hussey.*
6. Wells	Somerset	The Misses Livett.*
7. Marlborough	Wilts.	Rev. T. A. Preston.*
8. Strathfield Turgiss	Hants.	Rev. C. H. Griffith.
9. Croydon	Surrey	W. H. Miller.*
10. Watford	Herts.	Dr. A. T. Brett. J. Hopkinson.*

* Send Specimens.

11. Harpenden	Herts.	J. J. Willis.
12. Hertford	Herts.	R. T. Andrews.
13. Royston	Herts.	A. Kingston.
14. Braintree	Essex	Miss Row.*
15. Bocking	Essex	H. S. Tabor.*
16. Geldeston	Norfolk	Miss S. S. Dowson.
17. Cambridge	Cambridgeshire	H. N. Dixon.*
18. Cardington	Bedfordshire	J. McLaren.
19. Oxford	Oxford	F. A. Bellamy.*
20. Belton	Lincolnshire	Miss Woolward.
21. Hodsock	Nottingham	Miss Mellish.*
22. Macclesfield	Cheshire	John Dale.*
23. Parbold	Lancashire	Mrs. Coombs.
24. St. Michael's-on-Wyre	Lancashire	Miss Hornby.*
25. Carlisle	Cumberland	T. Hands.*
26. Killarney	Co. Kerry	Rev. G. R. Wynne.*
27. Yeovil	Somersetshire	Rev. J. Sowerby.*
28. Wellington College	Berkshire	S. A. Saunder.*
29. Isleworth	Middlesex	Miss E. A. Ormerod.*
30. Maresfield	Sussex	Mrs. Green.*
31. Sawbridgeworth	Herts.	Miss Simpson.*
32. Hitchin	Herts.	W. Hill, Junr.
33. Wickham	Essex	H. N. Dixon.*
34. Tacolneston	Norfolk	Miss Barrow.*
35. Addington	Bucks.	J. Mathison.
36. Tidenham	Gloucestershire	Miss Evans.*
37. Great Bourton	Oxfordshire	Oliver V. Aplin.*
38. Hampstead	Middlesex	Miss Donagan.
39. Cardiff	Glamorganshire	R. W. Rickards.
40. Cirencester	Gloucestershire	A. Harker.
41. Hatton	Lincolnshire	Mrs. Jarvis.*
42. Great Cotes	Lincolnshire	J. Cordeaux.
43. English Bicknor	Gloucestershire	Miss A. Machen.*
44. Woolaston	Gloucestershire	Miss A. Purchas.*
45. Buildwas	Shropshire	Rev. H. L. Graham.
46. Bagnalstown	Co. Carlow	Miss Wynne.*
47. Cushendun	Co. Antrim	Miss Wynne.
48. Wicklow	Co. Wicklow	Miss Wynne.*
49. Arboe	Co. Tyrone	Miss Wynne.

The last three months of 1882 were, upon the whole, warmer than the average; there were cold periods, especially during the first fortnight of December, but the year ended decidedly warm. Defoliation began about the middle of October, and by the end of the month the Ash and Horse

* Send Specimens.

Chestnut were stripped. Elms were yellow early in November, and about the 11th the Mulberry was defoliated. Ground temperatures began to rise in December, and early flowerings were not unfrequent.

The weather during January was mild, with much rain and fog and but little sunshine. At Parbold, in Lancashire, "flowers were very scarce;" whilst at Bocking, in Essex, "vegetation was rather more forward than usual, though less so than last year." Wild flowers, though still abundant in most places, were hardly so much so as last year, except in the South-west of England, where the numbers were nearly equal in the two years. An observer at Cardiff found no less than seventy species in flower, the largest number yet recorded from any one place in January—Cardiff must be a spot singularly suited for the preservation of wild flowers. At Marlborough vegetation was nearly a fortnight in advance of its average state (as computed for the previous 18 years), and at many other places the returns show an equally forward state, but there are some remarkable exceptions, Isleworth especially being much later.

This mild but wet and sunless weather lasted till the fourth week in February, when it turned fine but cold. "Vegetation was almost as advanced as last year" at Babbacombe, and was about a fortnight in advance of its usual state at Marlborough. At Yeovil "the dates were even earlier than in 1882, but not uniformly so"; some plants being earlier than ever before, whilst others were more than a fortnight later.

March was an unusually cold month, and the young vegetation suffered severely, all the young leaves being shrivelled up and the tender herbaceous plants cut down to the ground. This has been a source of much difficulty, as regards the Phenological Observations; for the first flowering being destroyed, observers have not unfrequently discarded their first records, whilst others have not. Thus the dates of the early flowers are extremely variable, rarely ranging over less than three weeks for different localities in the same district. A good deal of the autumn sown wheat was destroyed, and grass keep for the most part "disappeared"; but the land, especially strong clays, was brought into the finest possible working order, and where farmers were able to take advantage of it their prospects were very bright. Vegetation was, however, at a standstill. At Marlborough this did not begin till about the middle of the month, again showing that the check to vegetation does not follow immediately on a change of temperature. Reports of the effects of the severe weather on vegetation are universal; at Lewisham, the first Daffodil opened on March 17th, but it had been opening for more than a fortnight; Primroses and Wood Anemones were damaged by the frosts. At Harpenden "the foliage of the Dog's Mercury and Nettle especially suffered, the foliage of many evergreens was destroyed, and on the stiffer soils much wheat died off." At Hertford, however, "winter sown wheat was looking well." At Hatton, "the East wind set in on the 19th and blackened budding shrubs, and nearly killed Wallflowers, Primroses, &c.; many roses also were killed." The earliest notice of Frog's spawn is at Killarney, on February 5th, and on the 6th at Salisbury, and the notices continue up to

April 10th: no doubt the cold weather acted as a retarding element. At Cardington the spawn was seen on March 24th! "in ice;" at Belton it was seen on March 30th, "three days after the ice had thawed;" whilst at Cirencester "Tadpoles were hatched on March 2nd, and yet five weeks later fresh eggs were found." Leafage, which fortunately had not progressed very much by the end of February, was completely destroyed; the most forward was the Weeping Willow; all the young leaves were destroyed about March 24th, and at Isleworth it was only "sprinkled" on May 1st; at Cambridge the branches remained bare all the Summer.

With the exception of the first week, April was a cold month and vegetation was backward. It was also a dry month, very little rain falling till the last week. This was all the better for farm purposes, though a little more rain would have been advantageous. "Such a seed-time has not been known to the present generation." Leafage progressed slowly and without any checks. At Salisbury the Horse Chestnut began to be feathered as early as the 6th; and by the end of the month hedgerows were quite green, Elms were generally tinted, Oaks in half-leaf, and Beech and Birch in full leaf. At Marlborough the Horse Chestnut was only sprinkled, the Larch tinted, and Beech and Birch with only their buds bursting. At Cambridge Horse Chestnuts, Laburnums, Gooseberries, Privets, and Willows were in first-leaf by the 10th, and Limes, Sycamores, and Poplars by the end of the month. At Wincanton the flowers of the Ash were unusually abundant on the 22nd. At Hertford Ash trees were pretty generally in flower before the Oaks had even burst their buds; and at Parbold the Oak foliage was slightly before the Ash. Generally there was a good promise of fruit blossom, though Plum and Blackthorn were unusually scarce.

At Harpenden "early in April, owing to the dry surface soil, numbers of worms lay dead on the ground, with innumerable small slugs feeding on them," and at Isleworth Lady-birds were reported to be in large numbers.

The first half of May was cold; a sudden change to fine warm weather took place about the middle of the month, and this, aided by a little rain, brought vegetation forward, though it was not up to its proper state by the end of the month. Fruit blossom of all kinds (except plums in some places) was profuse though backward, Apples and Currants being especially mentioned. The foliage of other trees and shrubs (except that of the Hawthorn) is generally remarked as luxuriant. *Caltha* and *Ranunculus acris* at length began to recover, and a "second appearance" of them is reported from Cirencester. As an instance of the sudden change, at Cambridge there was no flower on the Horse Chestnut on the 14th, and yet the trees were covered on the 16th. The blossom of this tree appears to have been generally very scanty. At Bocking there was an excessive and unusual growth of "wild oats" even on land ordinarily free from them.

There seems to have been a general absence of "green fly" (*Aphis*), but the Large White Butterfly (*P. Brassicæ*) was exceedingly abundant (at Harpenden); large areas of Turnip and Clover were killed by the "fly," and Garden Slugs were extraordinarily prolific. Here and at Isleworth the larvæ

TABLE I.—DATES OF FLOWERING OF PLANTS.

No. and Name of Plant.	Babbacombe.	Tiverton.	Westward Ho.	Yeovil.	Wincanton.	Wells.	Cardiff.	Tidenham.	Woolaston.	English Bicknor.	Great Bourton.	Cirencester.	Marlborough.	Salisbury.	Strathfield Turgiss.	Wellington College.	Maresfield.	Croydon.	Hampstead.	Isleworth.	Oxford.	Addington.	Watford.	Harpenden.
1. ANEMONE NEMOROSA	..	(64)	70	54	123	47	..	55	..	..	..	94	42	47	61	64	60	62	..	91	71	97	77	62
2. RANUNCULUS FICARIA	53	8	6	11	3	10	10	(51)	..	..	..	62	3	6	46	34	36	28	58	55	36	53	35	56
3. *Ranunculus acris*	136	111	126	110	126	115	..	..	..	..	..	..	108	114	57	..	..	138	..	141	114	135	117	130
4. CALTHA PALUSTRIS	53	75	62	18	94	63	..	..	..	..	..	62	14	59	100	63	51	98	..	..	57	98	91	74
5. *Papaver Rhæas*	154	150	163	..	175	..	..	..	176	..	..	..	161	146	155	..	160	154	..	147	..	..	150	157
6. *Nasturtium officinale*	..	155	129	..	144	157	..	..	..	..	..	..	156	156	..	141	..	..	..	..	145	..	..	167
7. *Cardamine hirsuta*	136	100	76	96	99	110	67	59	..	..	111	73	90	93	112	106	99	104	..	..	110	111	117	110
8. *Sisymbrium Alliaria*	..	106	113	108	..	124	..	101	..	..	..	103	115	(106)	..	111	..	112	..	110	105	125	104	134
9. *Draba verna*	53	95	52	−2	49	..	..	..	..	..	..	60	33	46	76	57	..	56	..	53	13	..	..	46
10. *Viola odorata*	..	32	21	34	49	27	..	46	..	..	..	..	61	48	44	52	55	34	..	99	..	(46)	..	2
11. *Polygala vulgaris*	..	134	105	101	107	110	..	155	..	..	..	..	136	110	143	133	130	125	..	..	..	..	153	158
12. *Lychnis Flos-cuculi*	148	169	132	..	148	..	..	..	..	..	153	..	151	148	142	151	146	146	..	..	160	147	147	155
13. *Stellaria Holostea*	85	..	76	60	99	73	..	99	..	101	..	..	104	97	62	93	105	105	..	115	99	125	101	105
14. MALVA SYLVESTRIS	161	(172)	153	..	165	163	..	..	160	..	..	..	170	159	..	..	..	161	..	..	179	176	155	158
15. *Hypericum tetrapterum*	209	177	201	..	195	190	..	..	..	..	..	..	189	193	182	..	..	..	..	..	..	..	..	..
16. *Hypericum pulchrum*	170	183	180	..	170	189	..	..	..	..	..	..	184	178	..	..	..	181	..	..	..	..	167	180
17. GERANIUM ROBERTIANUM	117	114	(63)	118	126	(59)	..	129	..	..	119	..	139	127	..	141	121	132	..	147	122	141	139	141
18. *Euonymus europæus*	..	..	154	..	155	140	..	..	..	..	..	..	153	149	127	..	..	174	..	..	..	..	155	..
19. *Acer Pseudo-platanus*	..	123	144	..	146	..	..	..	..	..	136	..	142	137	..	..	..	137	..	..	143	..	..	..
20. *Æsculus Hippocastanum*	134	..	127	..	136	133	..	134	..	..	146	..	135	135	138	..	..	135	..	136	133	139	..	139
21. *Cytisus Laburnum*	133	142	137	..	137	136	..	132	145	..	146	..	138	136	141	..	..	137	..	136	137	141	137	141
22. TRIFOLIUM REPENS	151	139	149	..	161	151	..	146	..	..	..	..	157	141	134	145	..	147	..	147	114	150	147	151
23. *Lotus corniculatus*	138	..	105	..	134	139	..	..	..	..	157	..	147	127	134	144	131	125	..	..	..	150	144	158
24. *Vicia Cracca*	179	(203)	160	..	162	173	..	..	..	..	..	..	172	161	182	..	..	167	..	..	..	..	..	..
25. *Vicia sepium*	134	106	..	101	117	103	..	132	(140)	..	141	..	121	106	..	..	..	111	..	147	110	..	120	114
26. *Lathyrus pratensis*	165	176	146	..	161	158	..	..	193	..	..	..	156	157	151	..	160	158	..	..	156	..	155	162
27. PRUNUS SPINOSA	91	(83)	73	95	96	94	..	97	..	113	107	..	107	97	102	105	104	111	..	..	104	105	98	101
28. *Spiræa Ulmaria*	177	174	166	..	164	161	..	..	179	..	..	..	164	166	..	..	179	180	..	..	163	174	..	158
29. *Potentilla anserina*	138	141	119	117	133	142	..	140	..	..	..	..	139	131	147	135	146	160	..	142	138	145	146	154
30. *Rosa canina*	161	..	149	..	158	153	..	154	157	..	158	..	156	154	152	..	161	160	..	..	163	159	153	156
31. *Pyrus Aucuparia*	..	134	154	..	145	..	..	..	..	..	..	..	140	135	132	..	..	137	..	..	..	..	..	144
32. *Cratægus Oxyacantha*	140	138	125	..	139	135	..	128	..	..	137	..	142	136	139	140	..	131	..	136	135	139	140	138
33. *Epilobium hirsutum*	209	208	184	..	190	192	..	..	197	..	..	..	203	192	195	..	..	206	..	..	..	..	..	191
34. *Epilobium montanum*	..	155	161	..	163	164	..	.	..	..	..	..	158	164	..	..	164	167	..	..	..	..	161	166
35. *Angelica sylvestris*	..	..	..	..	208	..	..	..	..	..	..	..	207	208	199	..	..	216	..	..	..	..	..	..
36. *Daucus Carota*	..	202	167	..	192	185	..	..	..	..	..	..	158	163	..	..	..	177	..	..	..	..	..	..
37. HEDERA HELIX	..	..	..	..	265	259	..	..	..	..	..	..	263	247	..	..	257	252	..	..	..	..	..	..
38. *Cornus sanguinea*	..	169	174	..	167	164	..	..	165	..	..	..	170	159	..	..	..	167	..	..	..	..	163	164

No. and Name of Plant.	Hertford.	Sawbridge-worth.	Hitchin.	Royston.	Cardington.	Cambridge.	Braintree.	Booking.	Wickham.	Geldeston.	Tacolneston.	Belton.	Hodsock.	Hatton.	Great Cotes.	Buildwas.	Macclesfield.	Parbold.	St. Michael's-on-Wyre.	Carlisle.	Cushendun.	Wicklow.	Bagnals-town.	Killarney.
1. ANEMONE NEMOROSA	64	..	91	..	71	..	81	..	69	..	97	79	91	103	..	64	90	108	87	63	..	54	..	39
2. RANUNCULUS FICARIA	..	54	..	57	55	20	28	(65)	18	..	..	40	(60)	44	61	38	34	71	47	52	..	26	..	6
3. *Ranunculus acris*	110	138	114	134	108	122	113	..	..	133	..	141	..	141	..	..	(136)	..	135	..	..	..	..	(123)
4. CALTHA PALUSTRIS	102	..	..	100	92	55	73	..	81	..	102	87	107	107	..	..	115	108	97	104	..	85	..	57
5. *Papaver Rhœas*	158	..	..	150	161	151	149	..	..	143	152	148	162	..	158	..	183	..	..	..	..	..	150	..
6. *Nasturtium officinale*	162	..	..	..	155	144	150	..	..	..	..	130	176	..	..	..	158	..	..	153	..	..	150	140
7. *Cardamine hirsuta*	114	..	115	117	110	107	..	110	..	..	108	119	118	125	..	106	111	116	100	110	..	112	..	104
8. *Sisymbrium Alliaria*	106	..	..	..	121	113	108	..	..	..	113	126	121	..	..	..	136	142	..	121	..	120	..	106
9. *Draba verna*	62	..	..	89	71	−29	51	..	..	..	..	34	..	..	..	..	(100)	..	..	..	..	..	..	..
10. *Viola odorata*	..	47	..	14	49	19	42	..	..	..	..	..	..	..	..	..	..	..	64	58	..	39	..	13
11. *Polygala vulgaris*	149	..	137	135	..	135	121	..	..	..	..	..	..	..	..	..	134	144	..	(126)	..	..	151	83
12. *Lychnis Flos-cuculi*	151	149	127	..	143	143	147	..	..	143	..	157	(152)	156	151	..	160	165	160	160	..	..	161	153
13. *Stellaria Holostea*	97	157	107	115	115	..	63	103	92	..	98	130	117	..	..	..	112	99	107	110	..	98	..	92
14. MALVA SYLVESTRIS	158	..	164	160	160	152	164	..	..	153	(150)	174	171	..	160	..	176	..	183	..	..	..	..	(157)
15. *Hypericum tetrapterum*..	179	..	..	..	184	..	191	..	..	186	..	192	192	..	..	..	..	..	..	..	..	..	..	..
16. *Hypericum pulchrum*	175	..	..	180	..	..	187	..	182	..	..	..	..	..	..	..	179	..	191	189	..	..	..	166
17. GERANIUM ROBERTIANUM	121	135	135	133	140	134	139	137	..	136	..	142	135	138	134	..	148	149	151	154	..	120	..	119
18. *Euonymus europæus*	154	..	..	..	..	146	146	..	..	..	..	128	..	..	..	..	..	..	..	..	..	..	164	146
19. *Acer Pseudo-platanus*....	140	..	..	..	132	121	131	..	..	..	..	129	..	..	..	..	..	137	..	136	..	101	..	107
20. *Æsculus Hippocastanum*	133	147	..	..	138	135	135	137	..	135	..	136	136	..	..	..	143	..	..	143	..	..	123	116
21. *Cytisus Laburnum*	139	..	..	..	..	136	135	140	..	148	..	137	145	..	..	..	145	145	145	143	..	..	122	120
22. TRIFOLIUM REPENS......	153	149	144	144	150	136	144	155	..	138	..	149	..	..	..	..	156	..	..	157	..	..	149	131
23. *Lotus corniculatus*	164	147	137	143	140	136	152	149	..	150	..	148	..	..	159	..	143	..	142	146	..	..	137	125
24. *Vicia Cracca*	165	177	166	181	182	156	174	180	..	181	170	176	..	174	178	..	167	180	163	163	..	..	..	173
25. *Vicia sepium*	121	142	..	135	..	..	119	129	..	..	113	..	..	..	..	..	137	130	137	136	..	89	177	(87)
26. *Lathyrus pratensis*	166	159	165	160	158	156	152	..	..	161	155	165	174	174	157	..	167	177	168	161	..	..	155	..
27. PRUNUS SPINOSA	99	..	94	104	94	98	100	103	96	..	108	99	110	105	..	..	123	..	..	110	..	92	..	79
28. *Spiræa Ulmaria*	152	172	168	175	171	160	165	155	..	163	..	182	(180)	182	..	..	183	187	171	186	..	..	176	169
29. *Potentilla anserina*........	146	140	133	141	139	136	149	150	..	132	148	150	..	..	158	..	158	145	148	146	..	..	134	106
30. *Rosa canina*............	157	154	152	154	158	156	150	154	..	155	154	164	165	167	165	..	167	174	170	161	..	..	162	155
31. *Pyrus Aucuparia*	144	..	..	..	..	135	136	..	..	..	..	141	..	..	..	..	145	151	142	143	..	..	138	133
32. *Cratægus Oxyacantha* ..	134	139	..	..	138	127	133	..	..	(141)	..	137	(137)	138	..	..	146	140	145	123	116	..	123	121
33. *Epilobium hirsutum*	188	187	189	193	187	188	185	183	188	191	..	174	195	198	..	..	..	186	192	212	..	195	..	..
34. *Epilobium montanum* ...	158	167	..	..	163	166	161	..	..	175	..	..	..	..	..	..	173	181	..	176	..	..	..	156
35. *Angelica sylvestris*	213	..	..	..	208	..	..	219	..	217	..	..	220	..	..	..	..	..	..	199	..	..	..	..
36. *Daucus Carota*	..	..	..	186	186	166	..	..	..	168	..	..	..	..	..	..	..	..	..	186	..	..	..	..
37. HEDERA HELIX	..	..	..	..	252	..	..	258	..	269	272	..	264	..	..	..	..	..	..	..	..	265	..	252
38. *Cornus sanguinea*	153	..	..	..	170	165	161	166	..	164	..	149	..	..	..	..	..	..	..	..	..	..	..	144
39. *Syringa vulgaris*	127	134	..	..	137	127	133	..	..	130	..	135	146	..	..	..	143	142	145	125	..	120	..	115
40. *Galium Aparine*	140	137	133	143	135	136	136	147	..	129	..	147	..	..	..	..	175	..	182	157	..	..	..	161

TABLE I.—DATES OF FLOWERING OF PLANTS (*Continued*).

No. and Name of Plant.	Babbacombe.	Tiverton.	Westward Ho.	Yeovil.	Wincanton.	Wells.	Cardiff.	Tidenham.	Woolaston.	English Bicknor.	Great Bourton.	Cirencester.	Marlborough.	Salisbury.	Strathfield Turgiss.	Wellington College.	Maresfield.	Croydon.	Hampstead.	Isleworth.	Oxford.	Addington.	Watford.	Harpenden.
41. *Galium verum*	181	..	179	..	190	186	..	..	..	..	..	..	179	181	188	..	..	197	..	..	..	..	182	176
42. *Dipsacus sylvestris*	..	..	..	..	..	200	..	..	..	..	..	..	..	205	187	..	..	..	..	..	..	..	..	..
43. *Scabiosa succisa*	207	207	..	..	173	190	..	..	..	..	..	..	..	178	210	..	..	235	..	..	..	..	..	..
44. *Petasites vulgaris*	..	(47)	..	52	105	45	..	..	..	..	..	..	16	58	64	..	..	..	..	..	110	94	..	..
45. TUSSILAGO FARFARA	85	(50)	19	39	60	37	1	59	..	..	..	(50)	28	51	75	39	36	28	47	84	42	50	56	59
46. ACHILLEA MILLEFOLIUM	180	173	147	..	181	180	..	..	..	..	..	..	170	162	174	..	174	177	..	..	181	..	175	166
47. *Chrysanthemum Leucanth.*	136	138	128	122	150	147	..	140	141	..	..	..	151	127	139	139	147	143	..	..	..	145	146	145
48. *Artemisia vulgaris*	..	214	..	..	..	..	..	..	..	..	..	..	208	206	..	..	..	208	..	..	205	..	..	..
49. *Senecio Jacobæa*	197	(195)	179	..	145	..	..	..	..	..	..	..	191	175	144	..	..	187	..	..	..	..	182	171
50. CENTAUREA NIGRA	205	169	173	..	167	174	..	..	..	..	..	..	174	164	190	..	160	167	..	..	174	165	..	179
51. *Carduus lanceolatus*	183	167	174	..	194	197	..	..	..	..	..	..	186	191	..	..	..	188	..	..	202	..	..	172
52. *Carduus arvensis*	210	(192)	181	..	181	184	..	..	..	..	..	..	189	180	196	..	..	177	..	..	..	..	153	189
53. *Sonchus arvensis*	..	216	191	..	192	..	..	..	..	..	..	..	208	204	..	..	..	204	..	..	..	..	189	190
54. *Hieracium Pilosella*	138	141	146	120	139	135	..	..	..	..	..	..	139	131	..	..	130	145	..	..	159	147	..	142
55. CAMPANULA ROTUNDIFOLIA	..	..	..	..	..	198	..	..	205	..	..	..	181	173	191	..	..	208	..	..	..	..	..	190
56. *Ligustrum vulgare*	177	184	164	..	175	166	..	171	197	..	..	..	177	158	171	..	..	161	..	..	163	..	..	176
57. CONVOLVULUS SEPIUM	209	183	168	..	193	180	..	..	197	..	..	..	189	172	190	..	..	185	..	..	202	..	..	207
58. *Symphytum officinale*	..	..	139	118	127	117	..	..	..	..	..	..	134	111	..	..	..	144	..	..	131	..	..	148
59. *Pedicularis sylvatica*	..	111	94	109	107	110	..	..	..	..	..	..	136	113	160	..	130	145	..	..	..	..	..	..
60. *Veronica Chamædrys*	117	..	..	81	..	61	..	107	..	113	125	..	103	90	..	91	..	108	..	116	110	118	118	113
61. *Mentha aquatica*	229	216	..	..	209	..	..	..	..	..	..	..	..	214	..	..	..	..	..	..	..	..	..	..
62. *Thymus Serpyllum*	162	..	167	..	175	164	..	..	..	..	..	..	165	151	..	..	..	154	..	..	..	..	..	181
63. *Prunella vulgaris*	176	167	162	..	167	157	..	..	..	..	..	..	172	165	..	..	171	174	..	..	163	159	171	180
64. *Nepeta Glechoma*	83	72	52	62	78	64	..	99	..	..	..	102	75	62	104	89	..	82	..	92	88	90	77	76
65. *Galeopsis Tetrahit*	..	184	184	..	..	..	..	..	..	..	..	..	189	192	164	..	..	..	..	..	..	..	..	..
66. *Stachys sylvatica*	..	173	161	..	163	163	..	..	..	..	..	..	165	158	159	..	177	167	..	..	160	..	160	164
67. *Ajuga reptans*	124	106	94	106	107	102	..	102	..	..	125	..	104	106	135	111	108	111	..	141	131	118	137	137
68. PRIMULA VERIS	86	129	..	62	66	37	..	102	..	102	111	..	84	62	98	..	103	108	..	..	96	97	98	91
69. *Plantago lanceolata*	101	103	94	96	107	112	..	..	..	..	..	.	110	100	..	..	109	110	..	117	114	125	118	116
70. *Mercurialis perennis*	53	8	6	18	5	−11	2	52	..	..	..	..	17	6	52	24	14	−1	..	64	36	112	..	22
71. *Ulmus montana*	(66)	..	..	45	61	..	..	..	..	..	..	..	54	(53)	..	..	..	63	..	..	45	..	..	54
72. *Salix caprea*	59	62	53	58	61	61	..	..	..	..	..	..	54	58	92	50	..	53	..	62	..	96	73	64
73. *Fagus sylvatica*	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
74. *Corylus Avellana*	49	9	11	17	6	23	15	..	..	..	..	..	18	15	30	42	..	−1	..	25	..	..	27	45
75. *Orchis maculata*	167	169	160	..	151	153	..	155	..	..	..	..	156	151	(127)	..	149	160	..	..	..	159	153	162
76. *Iris Pseud-acorus*	164	153	146	..	158	157	..	..	..	..	..	..	152	143	..	..	145	148	..	..	150	..	154	157
77. *Narcissus Pseudo-narcissus*	..	33	46	59	58	49	..	55	..	..	..	..	44	48	69	50	51	..	..	65	63	66	..	77
78. *Galanthus nivalis*	..	(11)	..	18	13	30	(12)	..	..	..	..	..	18	8	21	..	22	..	..	40	..	13	20	20
79. [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

No. and Name of Plant.	Hertford.	Sawbridge-worth.	Hitchin.	Royston.	Cardington.	Cambridge.	Braintree.	Bocking.	Wickham.	Geldeston.	Tacolneston.	Belton.	Hodsock.	Hatton.	Great Cotes.	Buildwas.	Macclesfield.	Parbold.	St. Michael's-on-Wyre.	Carlisle.	Cushendun.	Wicklow.	Bagenals-town.	Killarney.
41. *Galium verum*	170	186	189	185	182	183	181	..	177	184	..	185	189	..	..	..	184	..	..	186	..	184	..	195
42. *Dipsacus sylvestris*	213	250	..	209	207	..	204	209	213	212	..	219	212	..	..	..	..	..	..	..	..	..	..	..
43. *Scabiosa succisa*	213	..	..	..	238	..	..	..	..	239	..	..	..	..	..	..	215	..	195	189	..	..	173	..
44. *Petasites vulgaris*	90	..	..	..	..	..	..	..	..	..	..	50	..	..	..	..	62	..	70	98	..	..	..	..
45. TUSSILAGO FARFARA	37	..	..	81	69	53	77	65	..	..	..	47	47	86	66	50	48	40	46	50	..	59	..	82
46. ACHILLEA MILLEFOLIUM	182	..	..	183	181	175	177	180	182	166	..	..	174	176	..	..	179	187	165	160	..	..	..	165
47. *Chrysanthemum Leucanth.*	141	148	140	143	129	136	121	150	..	143	..	154	154	..	152	..	160	168	152	153	..	..	149	141
48. *Artemisia vulgaris*	..	250	228	212	..	..	..	..	219	205	..	..	..	..	..	..	..	..	..	..	..	206	..	153
49. *Senecio Jacobæa*	182	193	206	181	184	..	184	221	186	150	..	187	197	198	..	..	176	..	189	190	..	..	(176)	181
50. CENTAUREA NIGRA	182	176	165	172	170	166	165	169	..	178	..	175	..	191	..	..	..	..	174	189	..	185	..	200
51. *Carduus lanceolatus*	173	207	171	..	197	..	190	202	191	197	..	185	(206)	..	..	..	222	..	186	191	..	..	..	204
52. *Carduus arvensis*	151	185	..	174	184	..	181	180	180	..	..	..	189	..	..	..	197	..	186	188	..	..	..	181
53. *Sonchus arvensis*	191	..	203	188	189	..	..	207	177	207	..	..	203	..	..	..	..	..	..	..	..	..	..	190
54. *Hieracium Pilosella*	124	156	..	146	131	142	163	161	..	132	148	149	..	..	..	..	151	..	157	146	..	..	134	136
55. CAMPANULA ROTUNDIFOLIA	184	..	188	195	..	188	191	..	191	195	..	198	194	196	..	..	209	188	190	182	..	..	..	181
56. *Ligustrum vulgare*	158	169	..	172	169	165	173	183	..	164	..	173	..	174	..	..	179	..	..	183	..	..	(176)	163
57. CONVOLVULUS SEPIUM	181	180	198	190	189	186	190	186	188	201	..	..	191	..	..	..	222	..	209	..	..	194	..	176
58. *Symphytum officinale*	144	136	..	..	..	122	131	147	..	..	..	..	..	..	..	..	..	..	..	..	..	..	137	141
59. *Pedicularis sylvatica*	152	..	..	..	..	..	..	..	..	..	..	..	..	131	..	..	134	144	..	130	..	..	132	138
60. *Veronica Chamædrys*	93	..	107	120	124	119	112	116	79	..	108	..	133	136	..	114	120	134	121	124	..	108	..	71
61. *Mentha aquatica*	213	..	..	..	217	..	210	213	..	211	..	..	..	..	..	..	..	201	..	..	..	..	..	231
62. *Thymus Serpyllum*	158	..	..	159	165	152	..	..	..	..	..	164	..	..	..	..	197	..	..	190	..	..	..	..
63. *Prunella vulgaris*	172	..	..	170	..	166	..	169	..	..	170	165	..	..	..	..	175	..	170	171	..	..	(167)	158
64. *Nepeta Glechoma*	62	88	..	105	83	..	63	..	83	..	82	91	107	98	..	90	118	128	97	105	..	77	..	50
65. *Galeopsis Tetrahit*	164	..	168	..	190	..	..	216	..	..	..	..	..	..	..	..	213	..	..	199	..	..	..	..
66. *Stachys sylvatica*	163	157	..	160	165	158	153	166	..	161	..	..	167	..	..	..	176	195	..	177	..	..	176	..
67. *Ajuga reptans*	121	140	..	132	132	123	115	122	..	127	107	131	132	126	131	114	122	144	138	139	..	..	151	111
68. PRIMULA VERIS	85	89	97	96	96	99	95	97	98	..	..	108	98	105	..	97	135	120	..	94	..	99	..	90
69. *Plantago lanceolata*	114	..	120	126	..	108	115	137	..	..	..	143	131	139	135	..	125	117	133	122	..	..	..	99
70. *Mercurialis perennis*	35	..	..	91	..	22	23	55	8	..	..	77	29	..	..	47	40	85	57	63	..	..	..	..
71. *Ulmus montana*	57	..	..	73	..	53	..	..	..	..	..	..	76	..	..	..	..	..	..	63	..	..	..	20
72. *Salix caprea*	77	..	..	74	91	64	81	..	..	..	..	92	76	..	..	..	64	74	..	61	..	..	..	..
73. *Fagus sylvatica*	..	..	..	..	..	..	..	..	..	..	..	147	..	..	..	..	..	..	..	..	..	..	..	..
74. *Corylus Avellana*	..	..	..	39	32	21	47	32	9	..	48	21	23	62	..	15	34	59	..	41	..	31	..	11
75. *Orchis maculata*	162	..	154	158	161	152	163	..	..	173	..	175	..	..	165	..	162	..	170	170	..	..	161	146
76. *Iris Pseud-acorus*	158	163	167	157	160	156	152	161	..	158	..	154	(160)	157	159	..	160	193	171	161	..	..	149	149
77. *NarcissusPseudo-narcissus*	64	..	..	..	73	(64)	..	..	83	..	90	..	91	..	..	..	64	99	62	..	..	54	..	50
78. *Galanthus nivalis*	14	12	..	22	12	..	19	20	17	..	..	8	17	34	43	..	(10)	44	21	..	..	15	..	13
79. SCILLA NUTANS	108	..	97	116	..	103	101		..	..	..	126	123	107	134	115	115	99	123	(125)	..	106	..	99

TABLE II.

Average date of the Flowering of Plants for each year from 1875 to 1883.

No. and Name of Plant.	1875.	1876.	1877.	1878.	1879.	1880.	1881.	1882.	1883.
78. *Galanthus nivalis*	14	31	18	28	41	46	36	16	23
74. *Corylus Avellana*	13	24	12	34	39	57	41	20	32
2. RANUNCULUS FICARIA	61	57	36	35	73	64	66	29	39
70. *Mercurialis perennis*	47	69	32	50	80	65	62	25	33
45. TUSSILAGO FARFARA	72	62	51	53	66	61	70	53	63
10. *Viola odorata*	48	50	46	56	70	64	72	35	48
72. *Salix caprea*	75	70	58	64	81	76	79	63	68
77. *Narcissus Pseudo-narcissus*	81	61	54	54	84	78	79	57	62
71. *Ulmus montana*	69	64	53	65	80	72	79	55	54
9. *Draba verna*	64	60	38	45	77	71	71	37	47
1. ANEMONE NEMOROSA	87	81	78	66	88	75	85	65	68
4. CALTHA PALUSTRIS	95	74	63	62	84	84	92	61	68
64. *Nepeta Glechoma*	100	92	91	74	101	86	93	76	81
27. PRUNUS SPINOSA	99	97	67	80	117	99	107	69	99
68. PRIMULA VERIS	99	97	87	85	110	86	94	78	87
7. *Cardamine pratensis*	108	107	96	88	119	99	109	89	110
13. *Stellaria Holostea*	111	103	84	97	126	106	107	72	94
79. SCILLA NUTANS	110	114	109	105	132	113	115	88	108
60. *Veronica Chamædrys*	109	116	104	89	122	102	115	85	111
69. *Plantago lanceolata*	118	110	112	113	131	114	117	101	115
3. *Ranunculus acris*	119	114	112	100	137	113	125	100	116
67. *Ajuga reptans*	127	122	127	119	139	117	128	108	125
17. GERANIUM ROBERTIANUM	125	126	124	120	143	120	128	97	134
40. *Galium Aparine*	128	146	144	134	155	142	143	129	137
22. TRIFOLIUM REPENS	138	149	154	138	162	147	146	132	147
29. *Potentilla anserina*	146	145	152	131	151	128	138	132	141
23. *Lotus corniculatus*	141	151	157	136	160	143	142	136	143
47. *Chrysanthemum Leucanthemum*	137	143	141	130	155	137	142	127	139
54. *Hieracium Pilosella*	141	143	145	131	159	136	142	123	134
12. *Lychnis Flos-cuculi*	137	153	156	139	164	146	148	138	149
26. *Lathyrus pratensis*	154	164	167	157	169	153	156	157	159
5. *Papaver Rhœas*	145	152	160	154	175	167	156	143	154
76. *Iris Pseud-acorus*	156	163	166	148	169	162	157	146	156
30. *Rosa canina*	157	164	165	151	178	162	159	149	158
14. MALVA SYLVESTRIS	158	169	169	160	180	168	160	156	160
66. *Stachys sylvatica*	164	170	170	154	176	160	160	158	162
34. *Epilobium montanum*	166	175	170	165	176	163	161	160	162
28. *Spiræa Ulmaria*	173	176	174	168	188	176	180	161	170
50. CENTAUREA NIGRA	162	179	178	168	189	175	172	174	182
41. *Galium verum*	176	185	182	183	196	185	179	185	181
52. *Carduus arvensis*	178	182	183	176	202	183	179	184	186
53. *Sonchus arvensis*	191	193	205	200	211	200	189	198	196
57. CONVOLVULUS SEPIUM	195	195	199	189	212	194	189	190	193

of the "Daddy-long-legs" (*Tipula*) were very prevalent and hurtful, especially to young Cabbages on light soils. The larva of the Frog-hopper (*Cercopis*) was very plentiful at Croydon.

At Wincanton "young rooks were plentiful, but some had not left the nest by the end of the month." At Hatton, however, "young rooks were very scarce, the frosts in March having killed the eggs or young birds.

By the middle of the month Horse Chestnut, Sycamore, Mountain Ash, and Lilac were generally in full leaf, and by the end Lime, Elm, Birch, Beech, and Apple, Spanish Chestnut, and Walnut nearly so, and Oak in

Station.	91. Brown Owl.	93. Song Thrush.	95. Nightingale.	97. Willow Wren.	98. Chiff-chaff.	99. Sky-lark.	100. Chaffinch.	102. Cuckoo.	108. Turtle Dove.	92. Flycatcher.	94. Fieldfare.	96. Wheatear.	103. Swallow.	104 House Martin.	105. Sand Martin.	106. Swift.	107. Goatsucker.	111. Corncrake.
Babbacombe	..	..	..	..	..	78	..	111	150	..	..	..	145	136	..	138	..	..
Westward Ho	..	..	..	..	91	..	..	116	..	114	..	88	93	88	..	126	..	..
Wincanton	..	..	127	..	..	..	..	109	..	..	..	..	109	128	..	133	..	143
English Bicknor	..	..	118	..	..	..	..	109	..	..	..	..	..	..	..	..	..	118
Great Bourton	..	..	118	105	97	..	..	110	140	134	..	..	110	118	..	125	..	136
Marlborough	..	..	..	..	..	49	..	118	..	..	..	..	94	..	104	131	..	116
Salisbury	..	..	118	..	..	51	..	109	..	..	..	..	105	125?	122	127	..	110
Strathfield Turgiss	..	..	111	..	..	..	..	107	..	..	..	..	102	111	..	130	170	134
Wellington College	..	32	119	112	118	34	36	109	..	145	..	..	103	119	123	126	..	..
Isleworth	..	19	112	..	..	25	..	108	..	..	..	..	112	105	..	..	..	..
Addington	..	4	135	..	..	36	85	109	153	..	10	..	99	..	..	135	..	135
Watford	..	..	112	..	..	21	..	106	..	..	..	..	102	105	..	125	..	125
Harpenden	..	1	109	..	..	6	..	108	..	..	..	..	118	104	..	123	..	131
Hertford	..	..	108	..	..	4	..	113	..	..	..	..	106	..	..	.	..	127
Hitchin	..	..	108	94	94	..	..	114	..	..	..	..	106	108	..	127	..	..
Royston	..	6	110	..	..	14	40	110	..	..	..	..	106	..	..	..	..	80
Cardington	..	..*	123	..	102	..	..	109	147	..	..	..	118	..	..	144	..	154
Cambridge	..	20	109	..	..	..	..	112	..	125	..	..	112	122	..	..	..	..
Wickham	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Tacolneston	..	..	112	98?	..	..	48	116	147	..	..	..	106	131	..	..	..	..
Belton	3	1	114	111	150	..	..	108?	..	137	..	..	100	120	114	129	..	135
Hodsock	..	..	116	..	..	..	..	118	..	..	..	..	109	..	120	128	..	..
Hatton	..	6	..	105	..	..	49	109	..	..	..	..	115	133	..	..	..	..
Great Cotes	..	32	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Buildwas	..	..	..	108	94	..	40	116	118	..	111	..	100	..	120	..	..	..
Parbold	..	..	..	..	..	41	..	113	..	..	..	..	107	..	..	..	..	109
Ripon	..	14	..	..	..	9	..	..	..	..	..	..	..	..	..	..	..	..
St. Michael's-on-Wyre	..	..	..	108	..	..	..	131	..	140	..	..	113	..	..	..	..	..
Carlisle	..	..	..	..	..	38	..	107	..	..	..	..	109	120	..	135	..	53
Arboe	..	..	..	..	97	..	..	91	..	..	..	..	95	..	..	..	..	103
Cushendun	..	..	..	..	..	..	..	97	..	..	..	..	..	..	98	114	..	..
Wicklow	..	..	..	..	..	..	..	113	..	..	..	..	105	..	..	..	..	117
Killarney	..	..	..	99	99	101	28	120	..	..	1–79	..	106	..	..	136	..	119

Station.	92. Fly-catcher.		93. Thrush.			100. Chaffinch.			101. Rook.			103. Swallow.		109. Partridge.		
	Eggs.	Sitting.	Nesting.	Eggs.	Young.	Nesting.	Eggs.	Young.	Building.	Nesting.	Young.	Eggs.	Young.	Pairing.	Eggs.	Young.
Babbacombe	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Westward Ho	..	..	..	88	..	..	..	..	..	..	..	..	..	..	..	..
Wincanton	..	..	..	..	..	..	..	..	..	..	112	..	..	..	..	..
English Bicknor	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Great Bourton	..	181	..	92	..	..	..	..	..	..	91	..	..	..	..	..
Marlborough	47	..	..	84	95	..	120	147	56	..	112	146	..	95	140	..
Salisbury	..	..	..	..	..	..	..	..	28	..	107	..	..	..	..	..
Strathfield Turgiss	..	..	..	66	..	..	..	..	..	..	..	..	..	..	101	..
Wellington College	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Isleworth	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Addington	..	..	..	64	..	..	..	..	58	..	..	..	..	43	..	176
Watford	150	..	..	..	..	..	..	..	..	56	..	..	..	..	..	..
Harpenden	..	..	..	..	..	..	..	..	..	55	..	..	..	..	..	..
Hertford	..	..	..	..	..	150	..	..	..	67	..	..	..	..	..	..
Hitchin	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Royston	..	..	..	..	..	..	..	..	..	51	..	..	..	..	..	..
Cardington	..	..	..	..	..	..	..	..	60	..	117	..	..	..	122	173
Cambridge	..	..	56	100	133	..	..	..	..	56	..	..	..	..	..	..
Wickham	..	..	..	..	..	..	..	..	47	..	..	..	..	..	..	..
Tacolneston	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Belton	..	..	..	100	..	121	..	..	35	..	95	..	..	..	..	..
Hodsock	..	..	..	102	..	..	..	..	..	..	..	..	..	..	..	..
Hatton	..	..	..	..	..	..	..	..	58	..	136†	..	189†	..	..	..
Great Cotes	..	..	..	..	..	..	..	..	62	..	..	..	..	..	..	..
Buildwas	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Parbold	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Ripon	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
St. Michael's-on-Wyre	..	..	..	..	..	..	..	..	74	..	..	..	..	..	..	..
Carlisle	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Arboe	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Cushendun	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Wicklow	..	..	..	..	..	..	..	..	..	57	..	..	..	..	..	..
Killarney	..	..	..	..	..	..	..	..	..	59	120?	..	..	..	..	..

* All Winter.

† Flying.

TABLE IV.—INSECTS.

Station.	80. Cock Chafer or May Bug.	81. Fern Chafer or July Chafer.	82. Bloody-nose Beetle.	83. Glow-worm.	84. Honey Bee or Common Hive Bee.	85. Wasp.	86. Large Garden White or Cabbage Butterfly.	87. Small Garden White or Cabbage Butterfly.	88. Orange-tip Butterfly.	89. Meadow-brown Butterfly.	90. St. Mark's Fly.
Babbacombe	..	..	..	..	..	112	..	117	..	..	117
Westward Ho	136	..	96	174	..	..	..	..	..	161	117
Wincanton	..	..	..	152	155	135	99	..	152	99?	..
Great Bourton	152	..	..	..	..	..	..	97	147	..	..
Marlborough	136	..	125	..	..	100	136	91	142	164	..
Salisbury	..	..	..	..	53	..	95	104	137	..	..
Strathfield Turgiss	..	..	103	..	39	89	163	112	128	141	131
Wellington College	148	..	..	..	..	119	133	95	121	..	..
Croydon	..	..	55	..	..	..	..	..	..	..	..
Isleworth	..	..	..	..	59	..	..	136?	..	..	..
Addington	..	..	..	..	..	55	141	112	156	170	..
Watford	..	..	..	168	22	140	95	98	..	..	..
Harpenden	145	..	142	181	..	144	64	94	151	142	182
Hertford	145	..	..	..	36	92	95	95	136	136	..
Sawbridgeworth	154	..	..	..	..	..	..	..	..	..	..
Hitchin	134	180	..	..	..	..	126	91	126	175	108
Royston	..	..	..	..	20	..	116	92	..	..	..
Cardington	..	..	..	..	..	94	95	..	..	..	..
Cambridge	..	..	..	..	..	108	..	..	136	..	136
Wickham	..	..	..	..	..	..	91	94	..	..	..
Belton	139	none	..	..	1	..	..	92	..	..	..
Hatton	..	..	..	..	..	104	..	104	135	..	..
Great Cotes	..	..	..	..	..	..	..	..	..	..	133
Buildwas	110	..	..	..	38	..	..	95	120	..	..
Carlisle	..	..	..	..	..	116	136	98	136	..	..
Cushendun	..	..	..	..	..	93	..	(93)	..	..	..
Arboe	..	..	..	..	..	..	..	..	124	..	..
Wicklow	..	..	..	..	58	..	..	..	..	..	..
Killarney	143	..	..	..	59	92	100	(135)	121	(96)	(123)

many places; but reports vary a good deal; at Marlborough the buds were only bursting on the 22nd. In Scotland the Oak was not more forward than the Ash, at Parbold it was very much so, elsewhere it was only a few days in advance.

The fine dry weather continued till the middle of June, and crops of all kinds were showing great promise. Foliage too, was wonderfully luxuriant, though vegetation as a whole was not as forward as usual. The only thing needed was a little rain for the Hay and Root crops, and that came during the second half of the month which was wet. Severe thunderstorms towards the end of the month did much damage to the Hay and Corn crops, the straw in some fields (at Hatton) being without a head. Haymaking began on the 4th at Strathfield Turgiss, on the 12th, at Great Bourton (Oxfordshire), on the 14th at Bocking (Essex), but not till the 21st at Babbacombe, and the 30th at Wincanton.

"Autumn sown wheat was coming into ear healthy and strong, but thin in places. Spring Wheat was thick and promising. All crops were late, but only a fortnight, having been a month late at the end of April." Reports were favourable from all quarters.

Hedge and field flowers were abundant, and there was very little appearance of blight; but in Hertfordshire there was an absence of Beech nuts, which had been singularly abundant last year. This appears to have been the case generally over England, for notice of flowering has been sent in only from one station; it certainly was so this year at Marlborough, but this is not an exceptional instance, for the bloom is frequently destroyed by early frosts.

Drought kept down the slugs (at Harpenden), but "fly" ravaged the Turnips and young Clover, and large areas had to be resown. A second sowing proved successful, the damp of the latter half of the month enabling the young plant to "grow past" the fly. About the middle of the month mildew and green fly were troublesome to Roses at Croydon.

July was cold and damp with little sunshine. The Hay harvest was much prolonged, and towards the end of the month the Potato disease appeared, the crop being heavy and fine. Strawberries and Raspberries were unusually fine, but much spoiled by the wet. Roses were good, and weeds, especially Thistles, were plentiful. "The heavy rains and somewhat wild winds broke down the corn in places, particularly where the crops were dense, and there was a tendency to mildew in the Wheat grain, owing to comparative lack of sunshine" (Harpenden). Notwithstanding the unfavourable weather, vegetation at Marlborough began to get in advance of its usual state.

August was a fine dry month and very favourable for harvest operations, which, though beginning late, were generally well advanced by the end of the month. At Wincanton some pieces of corn were not ripe by the 31st, owing to late seeding time.

Harvest began about the 11th at Bocking and Salisbury, the 16th (both Barley and Wheat) at Geldeston, whilst at Babbacombe Oats were carried on the 16th, Wheat on the 18th, and Barley not till the 24th.

Apples and Walnuts were plentiful, Plums and Wall fruit very scarce or wanting, and Pears moderately plentiful. At Wincanton Frogs were unusually abundant and Field Mice scarce.

The weather in September, though variable, was apparently not unfavourable for securing the crops. A gale on the 2nd was generally felt, and was remarkable for its long continuance; at Salisbury it damaged the foliage; yet the autumnal tints advanced only slowly, and by the end of the month the yellow sprays of the Elms were far from numerous. The Spindle and Elder were loaded with fruit, but still far from ripe. At Croydon the "heavy rains caused trees to be less autumnal in appearance at the end than at the beginning." At Marlborough the Limes alone were thinning, whilst at Geldeston Beeches began to change on the 30th, and Spanish Chestnut, Birch and Elm were thinning. It remained for the autumnal tints to be in all their glory in October, when they were unusually fine.

At Harpenden the great numbers of the Large White Butterfly (*P. Brassicæ*) and of the Cabbage Moth (*Mamestra Brassicæ*), which appeared in the earlier part of the season, were apparent from the ravages caused by their larvæ, which devoured the Cabbage tribe (especially Savoy and Sprouting Brocoli) in a remarkable manner. The larvæ of the Celery Fly (*T. onopordinis*) did much mischief there and in many other places.

At Wincanton the weather at the end of the month was unsettled, and several breadths of Wheat and some Barley were still uncarried. The Honey Harvest has been disappointing. Till the middle of June the prospects were bright, and in some few cases, where the stocks were strong, a fair quantity of honeycomb was taken; but the subsequent bad weather prevented the bees from gathering honey, and they consequently had to feed on what they had already stored up, the result being that almost everywhere it was impossible to get any honey.

One important lesson may be learnt from the experiences of the past year. Where farmers had a sufficient command of labour to take advantage of the favourable weather, the results have been excellent, and a prosperous year has been experienced; but on the other hand, where labour was scarce, farmers were unable to work their land at the proper time, their sowing was delayed, they lost the good time for harvest, and thus have not profited as much as they might have done by the excellent season of 1888.

Entomological Report.

The same remark that was made last year applies to the Entomological notices. There seems to be much confusion about the species, and it is therefore most desirable that specimens be sent with the Returns.

The Cock Chafer was reported from Buildwas on April 20th, which seems to be too early a date for this species. The next date is May 14th from Hitchin, and it appeared generally during the latter half of May.

The Honey Bee was noticed generally during January and February; but not till April 22nd at Babbacombe, and June 4th at Wincanton. The Common Wasp was observed as early as February 24th at Addington; and it was generally noticed between March 30th (at Strathfield Turgiss) and the end of April, but not till May 24th at Harpenden.

The Large White Butterfly was prevalent during the first half of April. It was reported on March 5th at Harpenden, which is evidently too early, and as late as May 16th at Marlborough and Carlisle, and June 12th at Strathfield Turgiss.

The Small White Butterfly appeared generally during the first half of April, and in the middle of May at Isleworth. The Orange Tip Butterfly appeared generally during the first half of May, and at the beginning of June at Harpenden, Addington, and Wincanton.

The Meadow Brown Butterfly is said to have appeared on April 6th at Killarney, and April 9th at Wincanton, but the other dates range from May

16th to June 24th. It was about a week later than last year and slightly after its average date at Marlborough.

If the dates given for St. Mark's Fly are correct, the time of its appearance cannot be very well named, as it ranges from April 1st (at Hitchin) to July 1st (at Hertford).

It is quite evident that the dates, as now given, are very unsatisfactory.

Ornithological Report.

Some few of the birds appear to have been well observed, and a comparison of the average dates will give a fair idea of the results of these observations. The records of the Swallow and the Cuckoo are numerous, and in some of the others the number of notices may be considered worthy of forming fairly reliable data. The song of birds this year began earlier than usual; but as the year advanced it got later and later, till in the case of the Turtle Dove it commenced at the same date as in 1879, the latest in previous years.

The song of the Thrush began with the new year, and the dates are extremely variable. It has been noted before at Cardington that, whenever the temperature of the air is above freezing, this bird is in song; it seems doubtful therefore whether these dates of song have any real importance. In the case of the Skylark, the dates vary from January 4th to April 11th. It was observed last year that this bird's note was entirely a matter of sunshine, a circumstance which, however, would hardly account for this great variation in the time of "first song."

The Chaffinch, which comes next in order of song, was apparently later than usual. It was heard in January at Killarney, but not till the end of March at Addington.

The Willow Wren began to sing about the middle of April, its average date being April 14th, the same date for three out of the six years of observation. It appears to have commenced singing about the same time all over England, from April 14th to April 22nd.

The Chiff-chaff was very late; nowhere did its song begin as early as the average date in any of the four previous years (*i.e.* during the last ten days of March). The earliest date this year was April 1st, at Westward Ho; the latest May 30th, at Belton. This last is probably erroneous. The next latest date is April 28th at Wellington College. Omitting the date for Belton, the average will be April 19th, about a fortnight later than for the previous four years.

The Cuckoo arrived about its usual date, April 21st. It was heard on April 1st at Arboe, and on April 7th at Cushendun, both in Ireland; but not till April 30th at Killarney. The other dates are nearly uniform. It changed its note on June 6th, near Oxford.

The Nightingale was a little later than usual. It was heard on April 18th in Hertfordshire, but not till May 15th at Addington, which the observer very truly remarks was "very late." It is curious that no notices of this

bird are recorded from any locality north of Belton. The dates sent in do not indicate a regular sequence in any direction.

The Turtle Dove was as late in coming as in 1879. It was first heard at Buildwas, in Shropshire, on April 28th; the next notice being more than three weeks later, near Oxford, and just a fortnight later at Addington.

The table of migration gives the opposite results to those obtained from the song, the mean dates being earlier than for any previous year, omitting the Martin, which was slightly later. Babbacombe, as usual, comes out latest, except in the case of the Swift. The date for the arrival of the Swallow (May 25th) is greatly retarded, and is twenty-two days later than in 1882. The Swallow was reported earliest from Westward Ho (April 3rd), and on April 5th from Arboe; the other dates range up to April 28th from Harpenden and Cardington, except the date from Babbacombe before alluded to. It is curious that the Swallow was seen at Watford on April 12th, and at other places near Harpenden on April 16th, but not at Harpenden itself till twelve days later.

The Sand Martin was seen first in Ireland on April 8th, next at Marlborough on April 14th, next at Belton ten days later, and eight days after that at Salisbury. These dates seem very unsatisfactory. The Swift was again seen first in Ireland, at Cushendun, on April 24th, but not till May 16th at Killarney. The earliest date for England is May 3rd, at Harpenden. Even as far north as Carlisle it was only twelve days later, except at Cardington, where it was not seen till May 24th.

The Corncrake was reported from Carlisle on February 22nd, and from Royston March 21st; there must be some mistake about these dates. At Arboe, again, it was reported on April 18th, and at Cardington not till June 3rd. These dates seem extraordinary, but they are connected by a regular series of intervening observations.

I cannot conclude this Report without returning my best thanks to Mr. W. F. Miller, our observer at Croydon, for the great trouble he has taken in tabulating the different returns, and in making a digest of them.

PROCEEDINGS AT THE MEETINGS OF THE SOCIETY.

NOVEMBER 21st, 1883.

Ordinary Meeting.

JOHN KNOX LAUGHTON, M.A., F.R.A.S., F.R.G.S., President, in the Chair.

The RIGHT HON. THE EARL OF DALHOUSIE, K.T., Brechin Castle, Brechin, N.B.;
THOMAS HENRY DAVIS, Glenview, Peel, Isle of Man;
DENNIS CAWOOD EMBLETON, M.R.C.S., Alington, Dean Park, Bournemouth;
JOHN HARGREAVES, 15A Market Place, Wigan; and
THOMAS LORD LEWINGTON, Queen's School, Basingstoke,
were balloted for and duly elected Fellows of the Society.

The PRESIDENT (Mr. J. K. LAUGHTON) then said:—

"In opening the present session, I have the pleasant duty of announcing to you that, as you have already been informed by letter, Her Majesty has been graciously pleased to recognise the importance and the value of the work on which this Society has been engaged, and to confer on it the distinguished and distinguishing title of "Royal." I cannot but congratulate the Society on this accession of dignity; and will at the same time permit myself to express the very great gratification which I personally derive from the fact that Her Majesty has chosen the closing months of my Presidency as the particular time in which to make known to us her gracious approval of our efforts in the cause of Meteorogoy. But I ought to add, that this honour now conferred on us will be considered by the outside public as a reason for increased exertion on our part. I may remind you of a very beautiful passage from that most delightful of all novels, "Westward Ho!" It is the passage where Sir Richard Grenville tells Amyas Leigh that "The best reward for having wrought well already is to have more to do: he that has been faithful over a few things must find his account in being made ruler over many things. That is the true and heroical rest which only is worthy of gentlemen and sons of God. As for those who either in this world or the world to come, look for idleness, and hope that God shall feed them with pleasant things as it were with a spoon, I count them cowards and base."

"Whilst I have to congratulate the Society on this matter, I have on the other hand to condole with it on the loss it has sustained by the death of two of its most distinguished Fellows, Mr. Greaves and Sir William Siemens. Of Mr. Greaves, who so lately occupied this chair, it is unnecessary for me now to say more; but of Sir William Siemens, who is probably more generally known by his labours as a physicist and electrician, I may say that it has been mainly by his liberality and assistance that the Society has been able to undertake the elaborate system of temperature observations on the Church Tower at Boston, a detailed report of which will I believe shortly be brought before us.

"I now come to the immediate work of the present meeting. From time to time, in examining the reports of the different stations, the Council has had to notice a certain difference amongst the thermometer screens, to an extent which, in some cases, was almost excessive. In calling attention to these differences, it seemed desirable to define the exact measurement of a Stevenson screen; and as it has long been suggested that the prescribed dimensions were too small, a Committee was appointed to examine the question from this point of view. This Committee recommended certain slight modifications in the Stevenson screen as ordinarily made, and Mr. Mawley was requested by the Council to bring these recommendations to a practical test. It is Mr. Mawley's report on this matter which is the first paper on our list for this evening, and which I now ask him to read."

The following Papers were read, viz.:—

"REPORT ON TEMPERATURES IN DIFFERENT PATTERNS OF STEVENSON SCREEN." By EDWARD MAWLEY, F.R.Met.Soc., F.R.H.S. (p. 1.)

"ON THE STORM WHICH CROSSED THE BRITISH ISLANDS BETWEEN SEPTEMBER 1st AND 3rd, 1883, AND ITS TRACK OVER THE NORTH ATLANTIC." By CHARLES HARDING, F.R.Met.Soc. (p. 7.)

"ON THE INFLUENCE OF THE MOON ON THE HEIGHT OF THE BAROMETER WITHIN THE TROPICS." By ROBERT LAWSON, INSPECTOR GENERAL OF HOSPITALS. (p. 25.)

"THE ICE STORM OF JULY 3rd, 1883, IN NORTH LINCOLNSHIRE." By JOHN CORDEAUX. (See *Meteorological Record*, Vol. III. p. 37.)

DECEMBER 19th, 1883.

Ordinary Meeting.

JOHN KNOX LAUGHTON, M.A., F.R.A.S., F.R.G.S., President, in the Chair.

RICHARD BENTLEY, F.R.G.S., Upton, Slough;
WILLIAM BONALLO, Cramlington Hall, Newcastle-on-Tyne;
EDITH BROOKE, Northgate House, Honley, Huddersfield;
REV. ALFRED CONDER, Middleton House, Bognor;
THOMAS HODDER COWL, Cooktown, Queensland;
JOHN A. WESTWOOD OLIVER, 13 Bruton Street, Berkeley Square, W.;
CHARLES MARTIN POWELL, Piccard's Rough, St. Catherine's, Guildford;
WILLIAM BLOMEFIELD TRIPP, M.Inst.C.E., 25 Great George Street; and
FUNG YEE, Chinese Legation, 49 Portland Place, W.
were balloted for and duly elected Fellows of the Society.

Mr. J. S. HARDING and Mr. H. S. WALLIS were appointed Auditors of the Society's Accounts.

The following Papers were read:—

"ON THE EXPLANATION OF CERTAIN WEATHER PROGNOSTICS." By the Hon. R. ABERCROMBY, F.R.Met.Soc. (p. 26.)

"PRELIMINARY INQUIRY INTO THE CAUSES OF THE VARIATIONS IN THE READING OF BLACK BULB THERMOMETERS *in vacuo*." By G. M. WHIPPLE, B.Sc., F.R.Met.Soc., F.R.A.S. (p. 45.)

"REPORT ON THE PHENOLOGICAL OBSERVATIONS FOR 1883." By the Rev. T. A. PRESTON, M.A., F.R.Met.Soc. (p. 52.)

Mr. J. S. DYASON, F.R.Met.Soc., exhibited a series of sketches of skies, illustrating the recent atmospheric phenomena during November and December 1883.

The Meeting was closed at 8 p.m., in order that a Special General Meeting might be held to consider certain alterations in the By-Laws.

DECEMBER 19th, 1883.

Special General Meeting.

JOHN KNOX LAUGHTON, M.A., F.R.A.S., F.R.G.S., President, in the Chair.

The Secretary having read the notice of Meeting, it was resolved:—

I. That throughout the By-Laws, the words "Royal Meteorological Society" be substituted for the words "Meteorological Society" wherever the latter occur.

II. That the existing By-Laws, Nos. 13, 14 and 15, which are as follows, be rescinded:—

"13. Each Fellow shall on his election pay the sum of One Pound for his admission fee; and, if elected before the 1st July, shall pay the sum of One Pound, but if elected after that date, shall pay the sum of Ten Shillings, as his contribution for the current year."

14. "Every Fellow shall pay an annual contribution of One Pound on each 1st January, for the ensuing year."

"15. Any Fellow may, at his entrance, compound for his contributions by the payment of Twelve Pounds (exclusive of his admission fee); or he

may, at any time afterwards (all sums then due being first paid), compound for his subsequent annual contributions by the like payment of Twelve Pounds."

III. That By-Laws 13, 14 and 15 stand as follows :—

"13. Each Fellow shall, on his election, pay the sum of One Pound for his entrance fee."

"14. Every Fellow (with the exceptions hereinafter mentioned) shall pay the sum of Two Pounds as his annual contribution to the Society, the said amount being due on the 1st January in each year. This contribution is payable by new Fellows on their election ; but Fellows whose first payment is due in November or December shall, on payment thereof, be exempt from that date until the 31st December of the following year. Fellows elected before the 1st January, 1870, shall have the option of continuing Fellows on the payment of the present rate of annual subscription, viz. One Pound."

"15. Any Fellow may, on his election, or at any subsequent time (all sums then due, including the entrance fee, being first paid), compound for all future annual payments by a single payment of Twenty-one Pounds."

IV. That the Resolutions come to by this Meeting, both those rescinding the present By-Laws and those enacting new ones, shall come into operation on and after the 1st January, 1884.

V. That a copy of the Resolutions now passed be sent forthwith to all Fellows of the Society.

CORRESPONDENCE AND NOTES.

METEOROLOGY OF ZANZIBAR.

The Assistant-Secretary, Royal Meteorological Society.

MY DEAR SIR,

I think it necessary, and perhaps you will allow me, to correct at least three inaccuracies in Dr. Peters's Paper in the *Quarterly Journal*, Vol. IX. p. 196, in so far as they have reference to my previously recorded observations.

1. The conclusion arrived at in the last sentence of paragraph 2 at page 198 is unwarranted as being contrary to fact. My observations were invariably kept by a clock regulated by the time-ball dropped from the yard-arm of H.M.S. *London* at 1 p.m. Zanzibar mean time, and, when the ball was not observed or available, by the chronometers of one or other of the various ships of war visiting the port. It would have been absurd to adopt for observation purposes any time so variable as an Arab-reckoned sunset.

2. In paragraph 4 on the same page "a few weeks" would more accurately read "three months," the observations of the first quarter of 1879 having been completed before I left for England in the beginning of April.

3. The position of the marine barometer in use by me was by no means so faulty as is described in the next paragraph (5) of the paper. Its position was fixed also according to the suggestion of Sir John Kirk, whose intimate knowledge of the house and of the requirements of such an instrument would at once settle the suitability of the exposure ; and I am in a position to state that the instrument was not, and could not at any time of the year be, affected by the rays of the Western sun. Moreover, the circumstances of Dr. Peters's residence differed from mine in several points which it is unnecessary to detail, and his particular private arrangements might have made it more convenient to have the barometer in the new position referred to, when he commenced observations with the new instrument from Bombay. At any rate, on my return to duty in April of 1881, I found it necessary to again alter the position of the new instrument, keeping the cistern at the same level however, and this change was at once reported to the Meteorological Office, Bombay.

4. The thermometers I had in use occupied the most suitable places available at the time, for the open room in which the new thermometer screen was placed was not constructed for some time after my first arrival in Zanzibar. This and other improvements connected with the premises eventually made better exposures of the various instruments possible, but I was supported in my opinion that a long series of observations in one position would be of more real value than one or two short series in different positions of the instruments, and they were therefore allowed to remain as they were at first placed. It ought to have been stated (if observed), as I have noted elsewhere, that the thermometer screen was not altogether protected from the rays of the setting sun by the "wooden venetian windows" mentioned on page 197, for I found it necessary to curtain a portion of the adjoining interspace to shade the screen from the afternoon sun, when it approached the northern limit of the arc of the horizon through which the luminary travelled during the year. I regret that these corrections of an interesting paper should have become necessary, but I would ask to be allowed to support as much as possible the accuracy and faithfulness of my own observations, considering the circumstances in which I worked. My official correspondence with Bombay was almost *nil*, and working up the observations in a private capacity and for my own information, it was with considerable disappointment that I afterwards learned that a Meteorological Department recognised by government had been in existence for some years so near as Bombay. It would have been a greater pleasure and profit to me to have introduced new instruments, and to have worked methodically in co-operation with the Bombay Observatory from the beginning, than to have followed my own plan considerably in the dark; yet there may be some little measure of satisfaction in knowing that the observations recorded by me and published by the Royal Meteorological Society as well as in India, gave effect to the officially recognised observatory at Zanzibar, so successfully inaugurated by my *locum tenens*, Dr. Peters.

The "conflicting interests" referred to by the President in closing the discussion of Dr. Peters's paper do not now exist, for in the latter part of the past year Zanzibar was separated from its Indian connection politically, and transferred to the Foreign Office entirely. The transfer has already resulted in the withdrawal of the Indian Medical Officer, and I understand that the Indian Native Medical Pupil lately intrusted to record the observations made will soon be withdrawn also, so that the work of the observatory will necessarily pass into other hands, if indeed the observatory itself will not cease to be a reporting station to the Bombay Observatory. It would be unfortunate if the change that has taken place should in any way interfere with the Observatory; and it is to be hoped that arrangements will be made to continue work of recognised importance.

I am, yours faithfully,

JOHN ROBB, M.D., F.R.Met.Soc.

Surat, India, January 24th, 1884.

AVERAGE RAINFALL FOR THE EIGHT YEARS, 1876 TO 1883, ON PENSHURST ESTATE, PEERMERD, TRAVANCORE, 4,000 FEET ABOVE SEA LEVEL. BY F. M. PARKER.

Month.	Average Rainfall.	Greatest Monthly Fall.		Least Monthly Fall.	
		Year.	Amount.	Year.	Amount.
	In.		In.		In.
January	·25	1881	·90	1876 & 80	..
February	·68	1879	3·24	1876, 78 & 80	..
March	3·38	1883	7·59	1878 & 82	·96
April	4·75	1877	8·86	1881	2·72
May	10·16	1883	19·36	1878	2·50
June	52·51	1882	81·74	1881	35·66
July	52·20	1882	96·97	1878	22·43
August	40·44	1883	62·59	1879	29·66
September	22·47	1878	39·46	1883	11·06
October	17·96	1882	27·29	1881	10·21
November	7·18	1883	10·99	1876	1·77
December	1·90	1877	6·83	1879	..

Average Annual Rainfall, 213·88 ins.
Wettest Year, 1882, 300·82 ins. and 207 rainy days.
Driest Year, 1881, 160·95 ins. and 206 rainy days.

RECENT PUBLICATIONS.

ANNALEN DER SCHWEIZERISCHEN METEOROLOGISCHEN CENTRAL-ANSTALT. 1882. 4to. 1883. 852 pp.

In addition to the Report of the Meteorological Commission this gives hourly observations from Berne, daily observations from fifteen stations, and monthly and annual results from eighty-five stations. The Appendix contains the following papers:—Ergebnisse der Niederschlagsmessungen auf den Regenmessstation der nördlichen Schweiz im Jahre 1882, von R. Billwiller (4 pp. and map).—Die jährliche Periode des atmosphärischen Niederschlages in der Schweiz, von Dr. J. Müller (16 pp. and plate). —Ueber den Gang der von Bimetallthermometern registrirten Temperaturen, von Dr. J. Maurer (8 pp. and plate).—Zusammenhang zwischen der Anzahl heller und trüber Tage einer Periode und deren mittleren Bewölkung, von G Mantel (10 pp. and plate).

ANNALES DU BUREAU CENTRAL MÉTÉOROLOGIQUE DE FRANCE, PUBLIÉES PAR E. MASCART, Directeur du Bureau Central Météorologique. Année 1881. Parts I., III. and IV. 4to. 1883.

Part I. contains:—Résumé des orages en France et de l'état de l'atmosphère pendant l'année 1880, par M. Fron (15 pp. and 20 plates).—Rapport sur les orages de l'année 1880 dans le sud-ouest de la France, par M. Lespiault (8 pp.). —Mémoire sur les tourbillons atmosphériques du golfe de Gênes, par J. R. Plumandon (6 pp.).—Températures du sol et de l'air observées au Muséum d'Histoire naturelle pendant l'année 1881, par MM. E. et H. Becquerel (6 pp.). —Etude sur le climat de l'Algérie, par A. Angot (30 pp. and 8 plates).—Pluviosité moyenne en France par vents des régions ouest, pendant les années 1877, 1878, 1879, par M. Rollin (39 pp. and 2 plates).—Marche diurne des divers éléments météorologiques à Sainte-Honorine-du-Fay, par A. Angot (15 pp.).—Climatologie du Roussillon, par Dr. Fines (112 pp. and 10 plates).

Part III. is devoted to rainfall, and in addition to a paper by T. Moureaux, Sur le régime des pluies en France pendant l'année 1881 (22 pp.), contains the daily rainfall observations from 1,497 stations, and is accompanied by maps, showing the distribution of rainfall for each month and season, and also for the year.

Part IV. contains:—Nouvelles cartes d'isothermes et d'isobares moyennes à la surface du globe, par L. Teisserenc de Bort (15 pp. and 8 large plates).—Etude sur l'hiver de 1879-80 et recherches sur la position des grands centres d'action de l'atmosphère dans les hivers anormaux, par L. Teisserenc de Bort (46 pp. and 224 plates).

Annuaire de l'Observatoire Royal de Bruxelles. 1884. 51 Année. 8vo. 1883. 270 pp.

This contains a valuable paper by A. Lancaster, entitled, La pluie en Belgique (110 pp.), in which the author has collected the rainfall statistics from 127 stations in Belgium, a few of which extend over a period of from thirty to fifty years. A table is given, showing the rainfall at Brussels for each month from 1833 to 1882. The mean annual rainfall at Brussels is 28·78 ins., the greatest annual fall was 41·20 ins. in 1878, and the least 17·68 ins. in 1864.

Annuaire de la Société Météorologique de France. 1883. Juin-Septembre. 8vo. 1883.

The principal contents are:—Sur un baromètre à gravité, par M. Mascart (7 pp.).—Les perturbations magnétiques et les aurores boréales du mois de Novembre 1882, par T. Moureaux (6 pp.).—Manuel de la prévision du temps à Bar-le-Duc, par M. Poincaré (28 pp.).—Sur le date de l'apparation des premières hirondelles au centre de la France, par E. Renou (3 pp.).—Sur la dépression barométrique du 31 janvier 1883, par V. Raulin (3 pp.).—Les cyclones et les grandes dépressions barométriques à Paris, en 1840 et en 1875, par V. Raulin (5 pp.).—Note sur les anomalies que présentent les courbes des baromètres enregistreurs pendant les orages, par M. de Tastes (2 pp.).—Note sur le climat du Tonkin, par Dr. A. Borius (2 pp.).—Rapport sur les conditions d'installation des garnisons au Tonkin, par M. Hamon (3 pp.).—Les températures dans nos deux hémisphères, par J. Péroche (7 pp.).—Contribution à l'étude du climat de l'Afrique centrale, par A. Angot (2 pp.).—La nébulosité à Bourges, par H. Duchaussoy (4 pp.).

Anuario del Observatorio Astronómico Nacional de Tacubaya para el ano de 1884. Formado bajo la Direccion del Ingeniero Angel Anguiano. Ano IV. 8vo. 1883. 358 pp.

This contains a short article on Meteorology, and also tables, giving the observations made daily at 7 a.m., 2 p.m., and 9 p.m. during the year 1882 at Chapultepec.

Archives des Sciences de la Bibliothèque Universelle. Décembre 1883. 8vo.

Contains:—Résumé météorologique de l'année 1882 pour Genève et la Grand Saint-Bernard, par A. Kammermann (140 pp.).

Army Medical Report for the year 1881. Vol. XXIII. 8vo. 1883. 363 pp.

Appendix X. (12 pp.) contains monthly and annual results of meteorological observations taken at the following stations, viz.:—Netley; Gibraltar; Malta; Nicosia, Troodas, Polymedia (these three in Cyprus); Scutari Cemetery; Fort Napier, Natal; Sierra Leone; Barbados; Newcastle, Up-Park Camp, Jamaica; Nassau, Bahamas; Bermuda; Singapore; and Hong Kong, China.

Anales del Ministerio de Fomento de la República Mexicana. Tomo VII. 8vo. 1882.

Contains:—Estudio físico-médico de los Terrenos de Huatusco y el Tizar en el Estado de Veracruz, por M. Barcena y G. R. Sandoval (35 pp.).—Recherches relatives à l'influence de la chaleur solaire sur la figure générale de la terre, par F. D. Covarrubias (4 pp.).

Bulletin Météorologique du Département des Pyrénées-Orientales. Publié sous les auspices du Département et de la Ville de Perpignan, par le Dr. Fines. Année 1882. 4to. 1883. 80 pp.

This contains tables which give the observations made every three hours at

the Perpignan Observatory; the daily observations at 9 a.m. at Amélie-les-Bains; and the monthly results from ten other stations.

Bollettino Mensuale dell' Osservatorio Centrale del Real Collegio Carlo Alberto in Moncalieri. Series II. Vol. III. Nos. VII. to IX. July to September 1883. 4to. 1883-4.

Contains:—P. F. Denza. Sulla variazione della temperatura secondo l 'altezza. The author before discussing various sets of observations shows that in order to determine satisfactorily the variation of temperature with altitude, observations made at stations at different levels give better results than those made in balloon ascents. Discussing ten years' observations made at Sacra di San Michele and Moncalieri which differ in altitude 700 mètres, Padre Denza finds the mean difference due to height varies with the season of the year. The mean value obtained is —0°·47 for 100 mètres of elevation. Subsequently taking one year's observations for Mont Cenis and Savona, in addition he finds a mean value of 0°·52 per 100 mètres. In a paper published in 1876, discussing observations made in the valley of Aosta, a mean value of 0°·63 was found, a result which perfectly agrees with the U.S. Signal Service Pike's Peak determination (1873 to 1879).—Gli Osservatorii Meteorologici pici alti del Globo. This is a summary of the Meteorological Observatories numbering 141 above 1,000 mètres above sea level, showing their distribution over the globe.—Il disastro di Casamicciola. This is a brief notice of the earthquake of July 28th, 1883.—Istruzione per le osservazione delle correnti terrestri del Prof. Ignazio Galli. The author has been experimenting for three years on the measurement of Earth Currents traversing wires which connect together plates about 20 centimètres square, sunk in the ground three or four mètres apart, and north and south and east and west of each other. He also measures the currents passing from the ground into the atmosphere by means of a wire led to the top of a conductor erected on the roof of a house.—Piatti:—Inaugurazione del l' Osservatorio di Desenzano sul Lago.

Ciel et Terre, Revue populaire d'Astronomie, de Météorologie, et de Physique du Globe. Vol. IV. Nos. 17-22. November 1883-January 1884. 8vo.

The chief meteorological articles are:—La météorologie en Allemagne (10 pp.).—Le nouvel Observatoire de Bruxelles (6 pp.).—La pluie sur et sous le sol, par T. Verstraeten (9 pp.).—La borne gnomo-météorologique de l'Ecole militaire, par Capt. C. Peny (13 pp.).—Les vagues atmosphériques provoquées par l'éruption volcanique du Krakatoa (4 pp.).

Instructions for making Meteorological Observations. Prepared for use in China. By W. Doberck, Government Astronomer. 8vo. 34 pp. 1883.

Dr. Doberck, who was recently appointed Government Astronomer at the Hong Kong Observatory, has been visiting the various Chinese ports, and found that there is no meteorological service in existence. He proposes to organise a series of stations, and has prepared these Instructions for the use of the intending observers.

Jahrbuch des Norwegischen Meteorologischen Instituts für 1882. Herausgegeben von Dr. H. Mohn. 4to. 1883. 114 pp.

This contains the daily observations at twelve second order stations, and the monthly and yearly results from thirty-nine stations in Norway for the year 1882.

Meteorological Atlas of the British Isles. Published by the Authority of the Meteorological Council. Official, No. 53. 4to. 1883. 10 pp. and 40 plates.

This Atlas is composed of four kinds of maps, viz.:—1. Thirteen maps, showing the distribution of mean barometrical pressure over the United Kingdom for each month and the whole year, during the twenty years 1861-1880; 2. Thirteen similar maps, showing the distribution of mean temperature during

the same period; 3. One rainfall map, showing the mean annual fall of rain over nearly the whole of the British Islands during the fifteen years 1866-1880; and 4. Twelve maps, showing for each month the mean temperature of the sea-surface immediately around our coasts. Tables are also given which contain the data on which the isobaric and isothermal charts have been constructed.

MINUTES OF PROCEEDINGS OF THE NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS. Vol. XXXII. 1883. 8vo.

Contains :—On water-gauge, barometer, and other observations taken at Seaham Colliery during the time the Maudlin Seam was sealed up, by V. W. Corbett (86 pp. and 2 plates). An explosion occurred on September 8th, 1880, and as several fires existed, it became necessary to seal up the Maudlin Seam. Half-inch iron pipes were inserted through all the stoppings for the purpose of attaching water-gauges. As the interior of the Seam workings might be considered to be a large gasometer, the readings of the water-gauges might be assumed to show clearly the difference between the atmospheric pressure prevailing outside the stoppings, and the pressure of the gases confined in the sealed-up workings. Observations were taken every hour; and those from November 22nd, 1880, to June 23rd, 1881, are represented by diagrams extending over 71 pages. Mr. Corbett shows that the water-gauge is extremely sensitive in marking every fluctuation of atmospheric pressure on the gases in the sealed-up workings, while the barometer is very tardy in recognising these fluctuations.

NOVA ACTA REGIÆ SOCIETATIS SCIENTIARUM UPSALIENSIS. Series III. 4to. 1883.

Contains :—Marche des Isothermes en automne dans le nord de l'Europe, par A. G. Högbom (8 pp. and 5 plates).

PROCEEDINGS OF THE AMERICAN PHILOSOPHICAL SOCIETY, held at Philadelphia, for promoting Useful Knowledge. Vol. XX. No. 113. 1883. 8vo.

Contains :—An improvement in the construction of the hypsometrical aneroid, by Dr. P. Frazer (1 p.). The improvement consists in constructing as much as possible of the aneroid of aluminium, and in making the case of cork, thereby considerably reducing its weight.

PROCEEDINGS OF THE ROYAL INSTITUTION OF GREAT BRITAIN. Vol. X. Part II. No. 76. 1883. 8vo.

Contains :—Weather Knowledge in 1883, by R. H. Scott, F.R.S. (11 pp.). It is shown that weather knowledge is practically weather prediction, and that, for the seasons, in Europe at least, no trustworthy basis for prediction has yet been established. Cirrus observations are in fact the only means available for giving early indications of changes of weather.

PROCEEDINGS OF THE ROYAL SOCIETY. Vol. XXXVI. No. 228. 1883. 8vo.

Contains :—Report of the Kew Committee for the year ending October 31st, 1883 (24 pp.).

PUBBLICAZIONI DEL REALE OSSERVATORIO DI BRERA IN MILANO. Nos. XVII. and XXIII. 4to. 1883.

No. XVII. Sui Temporali Osservati nell' Italia Superiore durante l' anno 1878. Relazione di G. V. Schiaparelli, E. Pini et P. Frisiani (99 pp. and 7 plates). This is an elaborate memoir on storms observed in Upper Italy during 1878. For the purpose of discussion of the observations the stations are grouped into thirteen districts, including Switzerland and Istria, and the storms into various periods. Professors Schiaparelli and Pini contribute a theoretical investigation of the storms, showing their dependence on the movements of the atmosphere in Western Europe.

No. XXIII. Osservazioni Meteorologiche Orarie Ottenute da Strumenti Registratori durante l 'anno 1881. This contains the tables and plates resulting from a discussion of the registrations of a Hipp barograph and an anemograph at the Milan Observatory for 1881.

Results of Rain and River Observations made in New South Wales during 1882: H. C. Russell, B.A., F.R.A.S., Government Astronomer for New South Wales. 8vo. 22 pp. and 2 plates. 1883.

This contains the rainfall results from 308 stations, and the table gives for each of these the rainfall and number of rainy days for each month and the year; and also the average, together with the number of years over which the observations extend. Over a large part of the colony autumn rains were below the average, and the winter and spring were very dry. The mean rainfall for 1882 was 20·11 ins., which is about 5 ins. below the average.

Sunshine Records of the United Kingdom for 1881. Reduced from the Original Traces from 31 Stations. Published by the Authority of the Meteorological Council. Official, No. 56. 8vo. 1883. 70 pp.

During 1880 Sunshine Recorders on Campbell's principle were supplied to several stations in connection with the Meteorological Office and the Royal Meteorological Society, and situated in different parts of the United Kingdom. The present work contains the records for 1881, which have been reproduced pantagraphically, and also a table giving the weekly totals of sunshine for each station.

Symons's Monthly Meteorological Magazine. Vol. XVIII. Nos. 214-216. November 1883-January 1884. 8vo.

The chief articles are:—Underground Temperature, by Prof. Everett (2 pp.).—Negretti and Zambra's turnover thermometers (2 pp. with plate).—The sunsets and the Java earthquake (8 pp.).—Heavy rain in North London, September 17th (2 pp.).—Rainfall at Rodrigues and Seychelles, by Prof. V. Raulin (2 pp.).—Whirlwind at Yeovil, November 17th (3 pp. and map).

The Encyclopædia Britannica. A Dictionary of Arts, Sciences and General Literature. Ninth Edition. Vol. XVI. 4to. 1883.

This volume contains an article on "Meteorology" (45 pp.), which has been written by Mr. A. Buchan.

The Journal of the Royal Agricultural Society of England. Second Series. Vol. XIX. Part II. No. XXXVIII. October 1883. 8vo.

Contains:—New determinations of Ammonia, Chlorine and Sulphuric Acid in the rain-water collected at Rothamsted, by Sir J. B. Lawes, F.R.S., Dr. J. H. Gilbert, F.R.S., and R. Warington (18 pp.).—On River Conservancy, and the cause and prevention of floods, by W. H. Wheeler (24 pp.).—Recent British Weather, by G. J. Symons, F.R.S. (11 pp.). The conclusions arrived at are that recent years have been characterised by low summer temperatures; and that, concurrently with these, the rainfall has been greatly in excess, especially in the central and western counties of England.

The Quarterly Weather Report of the Meteorological Office. New Series. Published by the Authority of the Meteorological Council. Part II. April-June 1876. Official, No. 33. 4to. 1883. 40 pp. and 29 plates.

The Report is accompanied by charts for each month, showing the distribution of mean pressure, mean temperature, rainfall, wind, and the movements of depressions, also isobaric charts for North-west Europe at 8 a.m. and 6 p.m. each day, and plates containing reduced reproductions of the curves from the self-recording instruments at the seven observatories. In Appendix IV. is given a comparison of the results obtained by means of the harmonic analyser with similar results from measurement and numerical calculation.

The Rosarian's Year Book. 1884. 8vo. 93 pp.

This contains an article by Mr. E. Mawley on the Rose Weather of 1883 (18 pp.), which has a table of monthly results of meteorological observations taken at Addiscombe during the year ending July 31st, 1883.

THE SCIENCE MONTHLY ILLUSTRATED. Vol. I. Nos. 1-3. November 1883-January 1884. 4to.

This new publication, which deals with many subjects, contains the following meteorological articles :—Some historical Floods (3 pp.).—Weather Lore (2 pp.).—Cloud observing, by the Hon. R. Abercromby (2 pp.).

TRANSACTIONS OF THE HERTFORDSHIRE NATURAL HISTORY SOCIETY AND FIELD CLUB. Vol. II. Part 6. October 1883. 8vo.

Contains :—Meteorological Observations taken at Wansford House, Watford, during the year 1882, by John Hopkinson (8 pp.). The following are the principal results :—Mean temperature 49°·0, mean maximum, 56°·1, mean minimum 41°·9 ; absolute maximum 77°·9 on August 12th, absolute minimum 15°·2 on December 11th ; total rainfall 33·57 ins.

ZEITSCHRIFT DER OESTERREICHISCHEN GESELLSCHAFT FÜR METEOROLOGIE. Redigirt von Dr. J. HANN. XVIII.-XIX. Bande. November 1883-January 1884. 8vo.

Contains :—Das Klima der britischen Inseln, von A. Buchan (10 pp.).—Das Anemometer der Station auf dem Säntisgipfel, von Dr. Maurer (5 pp. and plate). This instrument was made by Mr. R. Munro, F.R.Met.Soc., and has given great satisfaction.—Resultate der Anemometeraufzeichnungen vom August 1883 auf dem Säntisgipfel, von R. Billwiller (3 pp.).—Bemerkungen zu der Abhandlung des Herrn Dr. van Bebber über "die gestrengen Herren," von W. von Bezold (5 pp.).—Resultate der meteorologischen Beobachtungen an der österreichischen arktischen Station auf Jan Mayen 1882-83, von E. von Wolgemuth (6 pp.). This is an interesting account of the observations taken by the Austrian Polar Expedition in Jan Mayen Island.—Typische Witterungserscheinungen, von Dr. J. van Bebber (11 pp.). This is an abridgment of a paper, which is to appear in *Aus dem Archiv der Deutschen Seewarte*, on the average tracks and characters of depressions, in order to see how far weather can reasonably be foreseen for Central Europe. The results confirm the views put forward by the Rev. W. Clement Ley in his *Laws of the Winds*.—Die meteorologische Station auf dem Wendelstein, von Dr. C. Lang (4 pp.).—Eine Beobachtung kleiner Tromben, von E. Budde (3 pp.).—Ein Beitrag zum Thema "Sonnenflecken und Regenmengen," von v. d. Groeben (12 pp.).—Dr. W. Köppen über den Gewittersturm vom 9 August 1881 (8 pp. and plate).—Die aussergewöhnlichen Dämmerungs-Erscheinungen von Ende November und Aufang December 1883 (10 pp.).

ZEITSCHRIFT DES KÖNIGLICH PREUSSISCHEN STATISTISCHEN BUREAUS, Jahrgang 1883. 4to.

Contains :—Ueber den jährlichen Gang der Temperatur in Norddeutschland, von Dr. G. Hellmann (11 pp. and 2 plates). The author discusses the yearly range of temperature in North Germany during the thirty-five years 1848-1882, and gives the five-day means for twenty-five stations.

QUARTERLY JOURNAL

OF THE

ROYAL METEOROLOGICAL SOCIETY.

VOL. X. APRIL 1884. No. 50.

AN ADDRESS DELIVERED AT THE ANNUAL GENERAL MEETING, JANUARY 16TH, 1884. By JOHN KNOX LAUGHTON, M.A., PRESIDENT.

I MAY congratulate the Society on the frequency with which Nature illustrates our Annual Meeting with Meteorological phenomena more or less remarkable. 'Tis but a few years since the attendance of our Fellows was thinned out by a fall of snow, the heaviest within the memory of the present generation; two years ago, when you honoured me by calling me to this chair, we were in the midst of a term of unprecedentedly high barometric pressure; and to-night, when I yield back into your hands the office with which you entrusted me, we have one of the pestilential fogs which have rendered our city notorious—I am tempted to say infamous—amongst the cities of the world. Even though this fog is not exceptional in its intensity, and is perhaps scarcely beyond what a Londoner would call a haze, any one who has had to run the risk of being delayed for a couple of hours in a suburban railway train, or who feels the cavity of his chest doing duty as a soot bag, is reminded that there are meteorological problems on the right solution of which our health and our comfort very much depend.

As it was my duty at our last meeting to address you at some length on our financial position, it is unnecessary for me now to recur to that subject, further than to express my confident hope that the changes then resolved on will be found to be harbingers of a new era in the work of the Society.

Of that work during the past year the Report of Council has given you a

sufficiently full account; but it seems not out of place for me to supplement it with a short notice of some events of meteorological interest which have taken place beyond the limits of our own circle, or which have more particularly engaged my own attention. In doing so, I may begin by a reference to the delicate experiments with Biram's anemometers, which were described by our Fellow, Mr. Saxon Snell, in a paper published first of all in the *Engineer* of June 23rd, 1882, but re-issued in a pamphlet form in the early months of the last year. In these experiments, Mr. Snell, by means of a specially devised aspirator, caused a measured quantity of air to pass in a measured time through a Biram's anemometer, and the difference between the reading of the instrument and the known velocity of the current is taken as determining the index error, or the co-efficient of the instrument. The method is extremely pretty, and does seem to determine the co-efficient with great exactness, but the application of it to the problems of anemometry is perhaps doubtful, for the experimental current of air is led on to the face of the anemometer with an accuracy that in any freer observations would be quite impossible; and it is at least questionable whether the results of the experiments can properly be used for interpreting the records of the instrument under very different conditions.

Mr. Bertram, a mining engineer of Wigan, has been good enough to send me the record of some observations made also with a Biram's anemometer on a whirling bar placed in a specially constructed chamber: these too were made with very great care, and Mr. Bertram considers the results fairly accurate: I feel certain that if a whirling bar can give accurate results, those of Mr. Bertram are accurate: but there is always a suspicion of counter currents and eddies in connection with the whirling motion, which in itself differs markedly from any effect in nature. But what seems to me the most unpleasant feature of the whole thing is this—that two skilful and ingenious men, each conducting an independent series of observations with first-class instruments of the same type, arrive at results which they each consider satisfactory, and yet these results differ from each other by something like twenty-three per cent.; the one making the instrument register at the rate of 91, and the other of 114, for an actually measured velocity equivalent to 100 feet per second. Roughly speaking, Mr. Bertram's registered velocity is reduced to the actual by dividing by ·9: Mr. Snell's by multiplying by ·9. Such discrepancies, in observations made with very great care and considered satisfactory, are almost heart-breaking, and throw increased doubt on the whole subject; and indeed our Fellow, Mr. Hele Shaw, has suggested to me that nothing seems likely to meet the difficulties but making the anemometer travel a measured space in a straight line. The details of such a motion would be probably difficult, and certainly costly; but sooner or later, it or some other plan—I know not what—will have to be adopted, if this complex problem is ever to be solved.

The determination of altitudes by means of the barometer, or the reduction of barometric readings to sea-level, is another subject which has to me very great interest, but in which, I fear, I am not much advanced beyond my

stand-point of last year. You will, I hope, remember that I then expressed my disbelief in the accurate determination of heights, and in the value of reductions to sea-level. On that occasion, I referred to the opinion of Professor Loomis. I had not then seen a paper by Mr. G. K. Gilbert, of the U. S. Geological Survey,[1] which though published in 1882, did not fall into my hands till a few months ago. Mr. Gilbert attacks the problem in the interests of hypsometry, not of meteorology, and the conclusion at which he arrives is that "the difficulties which inhere in the use of the barometer for the measurement of heights are so numerous and so baffling, that there is no reason to hope they will ever be fully overcome." "The errors which affect the determination of the height of a mountain above its base are those of temperature, moisture, and diurnal gradient, while the difficulty encountered in determining the relative altitude of two stations upon a plain arises almost entirely from non-periodic gradient."[2]

We have more frequently to do with the converse problem, Given the difference of altitude to find the reduction of the barometric reading; and for this, as for the other, I am equally inclined to give in my adhesion to Mr. Gilbert's conclusion, and to repeat my belief that, in Mr. Gilbert's words, "the difficulties in the way are so numerous and so baffling, that there is no reason to hope they will ever be fully overcome."

For the purposes of a hypsometrical survey, and within certain not very wide limits, Mr. Gilbert proposes to evade the difficulties by referring each altitude (as of C) to a *vertical* base, carefully measured by actual levelling, at the ends (A, B) of which, barometric observations are made at short intervals; he thus corrects his altitude by the proportion,—

Height of B above A :	Height of B above A : :	Height of C above A :	True height of
(barometrically determined).	(determined by levelling).	(barometrically determined).	C above A.

This is, of course, merely the rough outline of his method, omitting all details and limitations. The results so obtained Mr. Gilbert considers fairly satisfactory, and, judging from the examples which he gives, they are much more accurate than those obtained in the more ordinary way. It does not, however, appear that this method could well be applied to the every-day reduction of barometric readings, though it might perhaps be modified for that purpose.

But supposing that this was done, that all difficulties of reduction were overcome, I would still as before ask, What does the corrected barometric reading signify? What is the true significance of an isobar, say of 30 ins., shown on the map as crossing or running along the Rocky Mountains or the Himalayas? I believe, or rather, speaking from personal experience, I should say I know that such isobars and such reduced pressures betray the un-

[1] A New Method of measuring Heights by means of the Barometer. Extract from the *Annual Report of the Director of the U. S. Geological Survey*, 1880-81. Washington, 1882.

[2] pp. 434-5.

wary, and possibly some who are not unwary, into a very serious misapprehension of the facts. We have, for instance, been all taught that in Eastern Siberia during the winter months the barometer is exceedingly high; a pressure of 30·7 ins. or even higher is definitely marked on the maps or recorded in the tables; and the inference is that there is a great accumulation of air in that locality. In point of fact, there is no such thing. The actually observed pressure of the air is, according to the height of the station, from one to two ins. lower. At Nertschinsk, where this extreme pressure of 30·7 ins. is recorded as the mean for January, the true observed mean is something like 28·7 ins.; at Irkutsk, another of the stations where a similar extreme pressure is recorded, the actual mean is also under 29 ins.[1]; and there is not in that region an enormous store of cold and compressed air presently to be poured forth over Western Europe. Beguiled by an isobaric chart, I was led to suppose that there was such a store of cold air, and to attribute our cold spell in May to its simple outflow. That is now a good many years ago, before grey hairs had taught me to mistrust every statement of fact till I had personally examined the evidence. I know now that the theory in its simple form is incorrect; and though I still think that this curiously regular cold spell is due to the high winter pressure in Eastern Siberia, its mode of action is certainly not that of a simple streaming out of the cold air; for the very plain reason that the accumulation exists only in the minds of the isobar manufacturer and his victims.

From this reference to one of the most marked peculiarities of Siberian meteorology, the transition to the recent or actual Arctic observing expeditions is easy and natural. You are all aware that in the summer of 1882, or even earlier, parties fitted out from different countries by international agreement were sent to so many different stations within or in the immediate neighbourhood of the Arctic circle. These stations were as follows:—

England -	at Fort Rae, on the Northern Shore of the Great Slave Lake.
Germany -	in Cumberland Sound; and at Pendulum Island, on the East Coast of Greenland.
United States	in Lady Franklin Bay; and another at Point Barrow.
Austria -	in Jan Mayen.
Sweden -	in Spitzbergen.
Norway -	in Finmark, at Bossekop.
Finland -	at Södankyla, in Lapland.
Denmark -	in Greenland.
Holland -	at the mouth of the Yenisei.
Russia -	at the mouth of the Lena; and another in Novaya Zemlya.

At the other end of the world, towards the Antarctic circle, Germany had also a second station in South Georgia, and France one at Cape Horn.

[1] *E. Stelling, Ueber die Seehöhen der Meteorologischen Stationen in Sibirien* (*Repertorium für Meteorologie, VI.* 11, 1879).

All these stations were more or less successfully established with the exception of that by the Dutch at the mouth of the Yenisei. The vessel, the *Varna*, in which this party was being carried to its post, was caught in the ice of the Kara Sea, was thus delayed for several months, and was eventually so nipped on the 24th December that she had to be abandoned with the loss of all her stores; but the wreck was still held up by the ice, and did not sink till the 24th of last July. The *Dymphna*, with the Danish party on board, was in company with the *Varna*, and in rendering help was herself beset at the same time, and passed through the same dangers, though with better fortune. She was thus happily able to receive the Dutch party when the *Varna* was crushed, and was still within 200 yards of the wreck in July, when it finally disappeared from view. She continued ice-bound till the middle of September, and returned home in the early days of November. The time was not however lost, and she has brought back a series of meteorological and hydrographical observations, as well as observations on the formation and nature of the ice, which may possibly prove even more valuable than if they had been taken on shore.[1] The members of the Dutch Expedition had left the *Dymphna* on August 1st in boats, and ultimately reached Vardö on the 30th of the month.

Of the American party which was landed in Lady Franklin Bay in the summer, no trustworthy news has since been received. The relief ships sent out in the summers of 1882 and 1883 were unable to reach the station, and the last, the *Proteus*, was herself completely crushed on the 23rd July, her crew escaping with difficulty. There is thus grave reason for anxiety as to the safety of this party, though it was, indeed, provisioned for three years; and the most determined efforts will be called for next summer to avert what, from serious danger, might well become a terrible disaster.[2]

With these exceptions, the several parties have carried out their programme pretty successfully. The results of their observations are of course not yet ready for publication; but a brief summary of such preliminary reports as have appeared will, I think, be interesting to you.

The report of Captain Dawson, of the Royal Artillery, who commanded the party at Fort Rae, has been laid before the Royal Society, and was published in *Nature* of 10th January. According to this, he has obtained a complete series of hourly observations of barometer, wet and dry bulb thermometers, anemometer, wind, clouds, and weather, from 1st September, 1882, to 31st August, 1883; and daily observations of rain-gauge for the same period. He notes, however, that "the anemometers did not work quite satisfactorily, being at times choked by ice; but he adds—"I hope by the comparison of the two, satisfactory results may be obtained." I must confess I do not quite see how. If two clean and freshly lubricated anemometers cannot give satisfactory results, how are two anemometers to do so when

[1] *Proceedings R. G. S.* pp. 603, 660. *Deutsche Geographische Blätter, herausgegeben v. d. Geographischen Gesellschaft in Bremen*, p. 374.

[2] *Proceedings R. G. S.* p. 733.

their oil is frozen and they are clogged with ice? However, that is Captain Dawson's affair, and I shall be very glad if he succeeds. "The wind," he says "was usually either South-east or North-west, and when it blew from the former quarter, the motion of the upper clouds often showed the existence of a north-westerly current." He has, however, described the station as situated on the south-west extremity of a peninsula that juts out from the north-east shore of a long gulf running in a north-westerly direction for more than 100 miles from the northern shore of the Great Slave Lake"; and it is perhaps possible that this general south-east or north-west direction of the wind is constrained by the shores of the gulf. "The hair hygrometers were found to be useless out of doors in cold weather, on account of the formation of ice on the hair." But notwithstanding these drawbacks of which I have spoken, and which may possibly disappear when we know more about the circumstances, the complete year's careful observations at such a station cannot but be exceedingly valuable.

The observations by the German party in Cumberland Sound seem to have been made with equal regularity during the twelve months beginning 15th September, 1882.[1] The year's range of temperature is given as from +20° to −48 C.(+ 68° to −54°·4 F.), this last in the beginning of February and of March. The barometer ranged from 720 to 783 mm. (28·347 ins. to 30·827 ins.), the changes frequently occurring with very great rapidity. "The strongest winds were generally from a northerly direction, and were accompanied by a remarkably great and quick rise of temperature: with such winds the thermometer several times rose from −30° C. (−22° F.) to above freezing point in the course of a few hours." A similar rise of the thermometer with northerly winds has been noted at other Arctic stations, and used to be brought forward as an argument in support of the now exploded "Open Polar Sea" theory. At many other stations, however, northerly winds have been noted as bringing with them the most intense cold; but at almost all stations some one wind is found to be marked by a rise of temperature. It is impossible to speak with certainty, but it seems most probable that such a wind is of the nature of the Swiss Föhn.[2] Towards the end of July the ground cleared of snow, and was immediately covered by a thick growth of various kinds of plants. More than fifty different species are spoken of; amongst them a beautiful yellow Erica, several kinds of Vaccinium, a yellow Poppy, and white Ranunculaceæ. This summer lasted but a short six weeks, during which the temperature by day rose sometimes as high as 20 C. (68°· F.) falling by night almost to the freezing point; and with the beginning of September came again frost and snow.

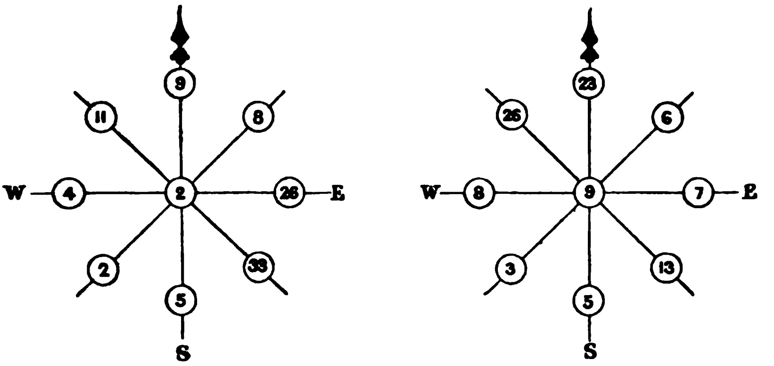
The Austrian observations[3] in Jan Mayen extend from July, 1882, to June, 1883, both inclusive. The difference between the insular climate of this

[1] *Blätter von der geographischen Gesellschaft in Bremen;* pp. 347 *et seq.*

[2] During the winter the Auroras were very frequent, and of extreme beauty.

[3] *Bericht des Leiters des österreichischen arktischen Beobachtungstation auf Jan Mayen kk. Linienschiffs-Lieutenant Emil, Edler von Wohlgemuth. (Beilage zu Mittheilungen aus dem Gebiete des Seewesens, Nr. IX. und X.)*

station and the continental climate of the others is very broadly marked. The weather was extremely wet and stormy, but the absolute minimum temperature was $-30^{\circ}\cdot6$ C. (-23° F.) in December, and the lowest mean was only $-10^{\circ}\cdot33$ C. ($+13^{\circ}\cdot4$ F.) in March; whilst on the other hand, the maximum was not more than $+9^{\circ}$ C. ($48^{\circ}\cdot2$ F.) in August, and the highest mean $+3^{\circ}\cdot39$ C. ($38^{\circ}\cdot1$ F.) in July. The barometer attained its lowest in February, 722·31 mm. (28·438 ins.), and its highest in March, 782·04 mm. (30·790 ins.); but these differences seem due, as in our own country, to the passage of well-marked cyclones. The monthly means varied between the minimum in February, 743·95 mm. (29·290 ins.) to the maximum in March, 761·39 mm. (29·976 ins.); the mean for the year being 754·47 mm. (29·703 ins.). The wind roses for February and March are as markedly different as the pressures, and the comparison is interesting. They may be thus given in percentages, the central figures denoting calms :—



FEBRUARY MARCH

But throughout the year the prevalence of South-east winds is very marked, attaining in October to a maximum of 41 per cent.: these were always warm, raising the thermometer in the middle of winter to the July mean, and melting the snow on the lava slopes: they seem to have been the advancing side of succeeding cyclones, the hinder part of which did not as a rule manifest itself, the wind generally dying away and the weather clearing when the barometric minimum had passed.

Of the Swedish observations in Spitzbergen I have not been able to procure any exact account. The lowest temperature reported is -32° F., but on the whole the winter was not so severe as had been expected. January and February were stormy and very cloudy, the three following months fine, though the sky was generally overcast, and the party enjoyed very fair sport. The Russian observers at the mouth of the Lena remain for another winter. They are said to have got pretty comfortably through the first, in spite of the cold, which, in agreement with our previous knowledge of the locality, was very severe. In January and February the thermometer seldom rose above -40° C. (-40° F.), and frequently fell below, -50° C. (-58° F.); the lowest temperature recorded was $-52^{\circ}\cdot3$ C. ($-62^{\circ}\cdot1$ F.) on the 9th February, at 7 a.m.[1]

[1] *Blätter v. d. geog. Gesell. in Bremen*, p. 375.

Of the exact value of this important work it is impossible to speak till the observations have been discussed and collated. Those from Point Barrow have, I believe, not yet been received; those from Lady Franklin Bay have certainly not, though we will not permit ourselves to doubt that we shall have them in due time. But when all have been gathered in and collated, it is pleasant to picture to ourselves the great gain to meteorological science which may be hoped for from such extended series of hourly observations round and within the Arctic circle. For years to come they will furnish work for the earnest inquirer into the secrets of Nature.

Of more immediate interest is the publication of the second volume of Baron Nordenskjöld's Scientific Observations during the voyage of the *Vega*,[1] which embodies much of the real work of that brilliant adventure. So far as we are concerned, the most important part of it is a very remarkable contribution by Otto Petterson "On the properties of Water and Ice," and on "The Hydrography of the Siberian Sea."

It is sufficiently well known that a very considerable climatic effect is attributed to the freezing of water and the melting of ice on a large scale; and the quantity of heat given out in the freezing or absorbed in the melting processes has been exactly calculated, but, from experiments made with fresh water. In these experiments it has been assumed, in accordance with a generally received idea, that ice, even when formed by the freezing of sea-water, is fresh; and the fact that water obtained by melting a lump of sea ice is not fresh has been either ignored or explained away by the assertion that some of the salt squeezed out of the water as it froze was held in the body of the ice in solid crystals, as so many flies in amber. But all this Mr. Petterson not only denies but disproves. According to him, ice from sea-water is salt throughout, and contains a peculiar selection of the salts of the water: the liquid residue is not a mere concentrated brine, as has been commonly supposed, but having received only the salts rejected by the ice, differs from the original sea-water, not only in the quantity of its salts, but in their relative proportion. This fact, if established—and Mr. Petterson speaks from a very exact investigation—is not, as it might appear, one of mere chemical or physical interest; for it follows that the ice so formed, itself constituently salt, neither gives out nor absorbs heat in the same way that fresh ice does; the freezing or thawing process is more gradual, and the dispersion or absorption of heat goes on for a considerable time.

What appears a most extraordinary example of this is given, from a perfectly independent source, in a report from the German Station in South Georgia. As the observers were being conveyed to their inclement home, by the corvette *Moltke*, they fell in, on the 7th August, with a large flat-topped iceberg; its length was estimated at 1,800, its breadth at 1,000, and its height at 35 metres; it contained therefore about 45,500,000 cubic metres, or 1,606,900,000 cubic feet of ice above water, and some eight

[1] *Vega-Expeditionens Vetenskapliga Jakttagelser, bearbetade af Deltagere i Resan och andra forskare, utgifna af A. E. Nordenskjöld: Andra Bandet.*

times that quantity below the surface; and yet, as the *Moltke* approached it to within 500 yards, the air temperature rose from $-2°$C. ($28°·4$ F.) to $-0°·8$ C. ($30°·6$ F.), and again fell as they left it behind.[1] Supposing this observation correct,—and under the circumstance I do not see how we can dispute it,—the rise of temperature must probably have been due to the fact, now stated by Petterson, that masses of sea-water ice continue giving out the latent heat of the water for a very considerable time after the ice itself is first formed. In any case it is important to note that a falling temperature is not a necessary concomitant of an approaching iceberg, and that a thermo-electric pile fitted to ring a bell on the first indication of a falling temperature (as proposed in the *Times* a few months ago) might very well fail to give the expected warning.

The formation of ice in the sea north of Europe takes place only in very high latitudes, for the water of the Gulf Stream, retaining traces of its warmth, spreads out from Spitzbergen to Novaya Zemlya: it does not appear to raise the temperature of the sea, but it prevents the formation of ice, for even at the freezing point, water cannot become ice if it cannot transfer its latent heat to a colder medium. It is this peculiar effect of the latent heat of the water of the Gulf Stream which Mr. Petterson thinks has been to some extent overlooked, and it has been maintained that because it had lost its sensible heat in the Barentz Sea, it has no climatic effect: he believes, on the contrary, that the latent heat which it carries with it, and does not lose till the moment of freezing, exercises a sensible effect on the climate many degrees still farther north. A large proportion of this polar ice is carried by currents to the coast of Greenland, and thence into comparatively low latitudes, where it melts; but as it melts, and afterwards, it absorbs and stores up solar heat, which again in due time it conveys to the far north, there again to give it out.

For several years, it has been known that the Kara Sea, the ice-cellar, as it used to be called, becomes navigable, and occasionally even clear of ice in August and September, and it has been well established that this is due entirely to the action of the warm water of the rivers of Siberia, and more especially of the Obi and Yenisei, flowing from more southern latitudes. The inference from this fact, which Mr. Petterson distinctly points out, I believe for the first time, is that the navigable conditions of the Kara Sea during its short season are entirely governed by the amount of sunshine and rainfall during the spring and summer in the distant regions of Central Asia. The warm water thus poured out into the Kara Sea is carried partly by its own inertia, but still more by surface drifts, to the far north; a persistence of southerly winds intensifies these drifts, and hurries the warm outflow away to higher latitudes; while northerly winds, on the other hand, press it back into the Kara Sea, and the neighbourhood of the coast. Hence, contrary to what might perhaps have been expected, the cold northerly winds tend to keep the sea clear of ice, the milder winds from the south permit the ice to

[1] *Blätter v. d. geog. Gesell. in Bremen*, p. 358.

remain. But the difference is not all gain, for the northerly wind drives what ice there is down on to the coast, and may thus render the navigation extremely difficult.

The southerly winds seem, however, to act detrimentally in another way: by means of the fresh water which they sweep to the far north, they bring a surface pressure on the cold sea-water below, which escapes towards the south as an under current of volume proportional to the pressure which gives rise to it. Such a cold under-current, forced nearer to the surface in the Kara Sea, is of course an additional hindrance to the melting of the ice; whilst northerly winds, tending to bank up the warm water, press back the cold. The effect of this is possibly more marked on the ice than on the general climatic condition; but it can be proved, says Petterson, that the main direction of the winds in August, during the years most favourable to navigation, was North and North-north-east.

I cannot close this short and necessarily imperfect account of the most recent Arctic observations, and of the latest theories on Arctic climate, without a mention of the valuable and comprehensive Handbook of Climatology (*Handbuch der Klimatologie*) by our Honorary Member, Dr. Julius Hann. It is a work far beyond any praise which I could venture to bestow upon it, and I speak of it now mainly because it contains the most comprehensive summary of former Arctic knowledge with which I am acquainted. It is not Arctic knowledge alone which is here summarised: the book is a compendium of climatic geography; and its publication would, of itself, be sufficient to make 1883 a memorable year in the annals of Meteorology.

A few months ago, I had the honour of representing this Society at a dinner given by the Lord Mayor to the Presidents of the several Scientific Societies of London. By some accident, I know not what, the representatives of the Fruiterers' Company were associated with us; but in returning thanks for the toast of our healths, the President of the Royal Society humorously explained it as a skilfully conceived allegory of our host's; for, he said, the science of our time, however abstract it may appear in many of its branches, must eventually be judged, and desires to be judged, by the fruit which it is capable of producing. We know that Meteorology is sometimes spoken of as a science somewhat barren of results, a mere piling together of observations, without either end or aim. Many of these are indeed, I fear, a sort of groping in the dark; but many, I hope and feel sure, are the seed which will germinate and bear fruit of a kind which, even from a commercial point of view, will prove most valuable; and of such promise is Dr. Hann's Handbook.

I have spoken of some of the achievements within the domain of our science which seem to me the most noteworthy during the past year; from these I must not omit the establishment of a permanent observatory on the summit of Ben Nevis. That too is surely seed from which we may hope for a rich harvest of fruit.[1] I had also intended to offer some remarks on the

[1] For an account of a visit to this on the 26th November, by Professor Chrystal, see *Nature*, of 3rd January.

wonderful sky effects which have been attributed, I believe rightly, to the eruption of Krakatoa on the 26th-27th of August last; but the numerous letters in the daily and weekly papers have already said so much on this subject, that, in the absence of any positive evidence, addition to it seems unadvisable. I may, however, call your attention to this, that, according to an account published only last week,[1] on board several ships in the neighbourhood, whilst the eruption was going on, the barometers—marine barometers, we may presume, with properly contracted tubes—were observed to pump violently; on board one ship, rising and falling between 28 ins. and 30 ins.; on board another, in jumps of from half-an-inch to an inch: and on board a third, from 750 to 763 mm., or rather more than half-an-inch. When we know that such monstrous effects were observed in the Java Seas, we can the better understand how traces of this agitation could be observed in western Europe, in the manner recently described by Mr. Scott and General Strachey before the Royal Society.

I must now conclude. I fear that some amongst you may think that I have been treating of Geography rather than of Meteorology: but you must, to a certain extent, have been prepared for it. So far as the little I have been able to do is known to you, you must have been aware that my Meteorology had a strong geographical bias. But, in fact, one science so mingles with another, that it is often difficult to say where the domain of one ends, of another begins; and on the one side, meteorology and geography interdigitate into each other, as do the Arctic Current and the Gulf Stream: on the other side of Meteorology lie experimental physics; and the ideal Meteorologist seems to me the man who can study the problems of Nature not in a spirit of selfish exclusion, but by welding the several parts into one grand and comprehensive whole.

REPORT OF THE COUNCIL

FOR THE YEAR 1883.

In presenting their Report, the Council have to express their consciousness of the important nature of the events of the last few months, and their belief that the present time marks a very critical epoch in the history of the Society.

At the meeting of the Council in October, the President announced that, through the support of the Earl of Dalhousie, K.T., he had received a letter from the Home Secretary informing him that Her Majesty had been graciously pleased to grant to the Society permission to assume the prefix "Royal." In consequence, the Society has become, and will henceforth be called, the "Royal Meteorological Society," and its Fellows will be designated by the letters F.R.Met.Soc., the more simple F.R.M.S. being already in use by the Fellows

[1] *Nature*, 10th January.

of the Royal Microscopical Society. In formally placing these changes on record, the Council congratulate the Fellows on this royal recognition of the value of the Society's work.

In consequence of a very general feeling that the income of the Society was insufficient to meet the expense of the work which it had undertaken, and that its usefulness was likely to be seriously curtailed by want of funds, the Council brought the matter before a General Meeting of the Society, specially convened on the 19th December, when, after full discussion, it was resolved that the subscription should be increased, and that By-Laws 13, 14, and 15 should be altered to the following:—

"13. Each Fellow shall, on his election, pay the sum of One Pound for his entrance fee."

"14. Every Fellow (with the exceptions hereinafter mentioned) shall pay the sum of Two Pounds as his annual contribution to the Society, the said amount being due on the 1st January in each year. This contribution is payable by new Fellows on their election; but Fellows whose first payment is due in November or December shall, on payment thereof, be exempt from that date until the 31st December of the following year. Fellows elected before the 1st January, 1870, shall have the option of continuing Fellows on the payment of the present rate of annual subscription."

"15. Any Fellow may, on his election, or at any subsequent time (all sums then due, including the entrance fee, being first paid), compound for all future annual payments by a single payment of £21."

The Thermometer Screen Committee, in concluding their investigations with respect to the most suitable size for a Stevenson Screen and the best positions for the thermometers to occupy within it, have brought up an exhaustive Report upon the subject (see Appendix I. p. 92). A screen was constructed in accordance with their recommendations, and most carefully tested by Mr. Mawley during the months of July, August and September. The results of his observations, taken in the new screen and in one of the old pattern, show that the differences are small, and that the temperatures obtained by the use of either screen are fairly comparable. The summary of the results obtained is as follows:—

Screen.	Mean Max.	Mean Min.	Mean of Max. and Min.	9 a.m.	3 p.m.	9 p.m.	Mean of 9 a.m and 9 p.m.
Temperatures in the New Stevenson Screen above or below those in the old pattern	° −0·1	° +0·0	° −0·1	° +0·0	° −0·2	° −0·2	° −0·1

The Council, while recommending this screen to their observers as in some respects superior in construction to the one now in general use, wish it at the same time to be clearly understood that they do not consider the above differences sufficiently important to justify them in giving a decided pre-

ference to one screen over the other. In order, however, to discourage Stevenson Screens being made much larger or much smaller than either of the screens referred to, they deem it advisable to add that, in their opinion, no screen should differ in any of its internal measurements more than 4 ins. from the new pattern. This pattern screen has accordingly been placed in the Society's Library, where it can at any time be examined. Its internal dimensions are as follows:—width 18 ins., depth 11 ins., and height 16½ ins. It is recommended that the maximum and minimum thermometers be placed in the screen in front of the dry and wet bulb thermometers.

The Committees appointed during the year to assist the Council in their work are as follows:—

General Purposes Committee:—The President, Secretaries, Foreign Secretary, Treasurer, Mr. Ellis, Mr. Latham, and Mr. Lecky.

Editing Committee:—Mr. Eaton, Mr. Scott, and Mr. Whipple.

Exhibition Committee:—The President, Mr. Ellis, Dr. Marcet, Mr. Symons, and Mr. Whipple.

Experimental Research Committee:—The President, Mr. Abercromby, Prof. Archibald, Mr. Eaton, Dr. Gilbert, Mr. Russell, Mr. Scott, and Mr. Symons.

Thermometer Screen Committee:—Mr. Ellis, Mr. Mawley, Rev. F. W. Stow, Mr. Strachan, and Mr. Whipple.

Decrease in Water Supply Committee:—The President, Mr. Field, Mr. Latham, and Mr. Symons.

Increase of Subscription Committee:— The President, Secretaries, Foreign Secretary, Treasurer, Mr. Beaufort, Mr. Dyason, and Dr. Williams.

There have been but few changes in the stations during the year: the only new stations being, London (Old Street, E.C.), established at the cost of the Society, and Stowell; while those discontinued are Beacon Stoop, Bournemouth, Cockermouth, Cranleigh, and Dartmoor.

The Meteorological Council have accepted copies of returns from Killarney and Margate in place of those from Dartmoor and Ramsgate.

The observations made at Boston Church during 1882 with the Electrical Thermometer placed at the disposal of the Society by the late Sir William Siemens, have been discussed, by the aid of a grant from the Government Grant Fund, and the results embodied in a paper by Mr. G. J. Symons, F.R.S., which, with the approval of our President, was read before the Royal Society. The paper has been printed in the *Proceedings of the Royal Society*,[1] from which the following summary is extracted:—"It seems that the difference between the temperatures at 4 ft., and 260 ft. is chiefly regulated by the amount of cloud, and by the relation of the temperature of the surface of the ground to that of the general body of air passing over it. If so, it will follow that the mean difference between the temperature at the two heights can only be determined by very numerous observations, or by careful consideration of the conditions of weather and of soil temperature under which each set is made."

[1] Vol. XXXV. p. 310.

The Rev. G. Morrison of Foula Island, Shetland, having offered to observe for the Society, if supplied with the necessary instruments, the Council, considering the great value of a station in that remote island, have lent Mr. Morrison a set of thermometers and a Stevenson screen, and it is hoped that the observations were commenced on the first day of 1884.

A new Table has been added to the *Meteorological Record*, giving the daily maximum and minimum temperatures at Old Street, E.C., Regent's Park, the Royal Observatory, Greenwich, and the Kew Observatory, Richmond, as well as the duration of bright sunshine at Bunhill Row (adjoining Old Street), at Greenwich, and Kew. A comparison of these observations will afford interesting results, which will be laid before the Society in due time, but meanwhile the Council desire to draw attention to them as being an important contribution to the Meteorology of the Metropolis. It must be remembered, however, that the thermometer stands at these stations are of three different patterns.

During the year the Assistant-Secretary visited most of the stations in the northern half of England and in Wales, and found them generally in an efficient state. In several cases, however, the zeros of the thermometers had changed since the instruments were verified. At one station which had not previously been inspected the thermometers were found to have altered as follows:—Dry $+0^{\circ}\cdot6$, Wet $+0^{\circ}\cdot3$, Maximum $+0^{\circ}\cdot9$, Minimum $-0^{\circ}\cdot8$, and the grass minimum as much as $-5^{\circ}\cdot0$. In this last there was no appearance of fracture, and there was no spirit at the top of the tube. These variations show the importance of a frequent and periodical comparison of the instruments, especially in melting ice or snow. For other information on this subject the Council refer to the Report which forms Appendix II. (p. 94.)

A new and revised edition of *Instructions for the observation of Phenological Phenomena* was published early in the year, and a circular issued to the observers. New forms to correspond with the revised list and numbers of the Plants, Insects and Birds contained in the second edition of the Instructions have also been printed and issued to the observers. The report on these observations during the past year has again been drawn up by the Rev. T. A. Preston, to whose zealous and cordial co-operation the Council is much indebted.

Besides the ordinary donations of books, a list of which is printed in Appendix VI., the Council have received from the executors of the late Mr. N. S. Heineken, of Sidmouth, a bequest of the MS. meteorological journals kept by him at that place from May 1836 to January 1868, and also a maximum and minimum and an ordinary thermometer, together with a small metallic thermograph constructed by him. They have also received from the late Mr. Greaves, Past-President of the Society, the sum of £10 towards the funds of the Society.

The Papers read at the Meetings have been interesting and instructive, and quite equal in scientific value to those previously presented.

The Annual Exhibition of Instruments at the March meeting was specially devoted to Meteorological Instruments which had been designed for, or

used by, Travellers and Explorers. Several new instruments, constructed since the last exhibition were also exhibited. A complete list of the exhibits will be found at p. 174, Vol. IX.

The Council have arranged for an exchange of the *Quarterly Journal* with *Science*, a new weekly scientific journal, published at Cambridge, Massachussets, and an exchange of the *Meteorological Record* with the new English journal *The Science Monthly*, which was first published in November.

The office-staff remains unchanged, and has improved in efficiency during the year, as the juniors have acquired greater knowledge of their work, and have been as assiduous in the discharge of their duties as in former years.

The Library having grown rapidly during the last few years, and its value being therefore considerably increased, the Council have insured it for £1,000 instead of £500. As a considerable number of volumes require binding and additional shelves are urgently needed, it will be necessary to lay out a larger sum on the Library in 1884 than in 1883.

The financial position of the Society was so fully discussed at the Special General Meeting held in December, that it is now only necessary to say that though the balance-sheet does not look so unfavourable as was then anticipated, the improvement is in appearance only, and is in consequence of several life compositions having been paid in. These payments are however to be considered in the light of capital rather than income, and will be wholly or in part invested in accordance with the general rule of the Society.

The following summary for 1880-83 shows the total sum received in each year from the Fellows, and the mode in which the amounts were paid. The increased expenditure has been incurred chiefly on the *Quarterly Journal* and the *Meteorological Record*.

	1880.			1881.			1882.			1883.		
Subscriptions ...	£355	2	0	£399	6	6	£491	5	0	£425	8	0
Entrance Fees ...	47	0	0	77	8	0	44	2	0	32	2	0
Life Compositions	144	0	0	132	0	0	71	0	0	199	10	0
Totals	546	2	0	608	14	6	606	7	0	657	0	0

The Society has to deplore the loss by death of one of its Past-Presidents, Charles Greaves, M.Inst.C.E., F.G.S., elected March 11th, 1851; and of five other Fellows—Francis Thomas Bircham, elected November 20th, 1878; Rev. Richard Drake, elected June 15th, 1881; William Scott, elected March 18th, 1874; Sir Charles William Siemens, D.C.L., LL.D., F.R.S., M.Inst.C.E., elected March 21st, 1883; and Professor Henry John Stephen Smith, M.A., LL.D., F.R.S., elected February 20th, 1878.

The number of Life Fellows on the roll of the Society is 130, being an increase of thirteen in the year; and of Ordinary Fellows 419, against 436 last year; and there are nineteen Honorary Members, thus making a total of 568.

Fellows.	Life.	Ordinary.	Honorary.	Total.
1882, December 31 ...	117	436	18	571
Since elected	+ 3	+34	+1	+38
Since compounded......	+12	−12	...	0
Deceased	− 2	− 4	...	− 6
Retired	...	−29	...	−29
Defaulters	...	− 6	...	− 6
1883, December 31 ...	130	419	19	568

APPENDIX I.

Report of the Thermometer Screen Committee.

The Committee has much pleasure in submitting for the approval of the Council a pattern Stevenson Thermometer Screen, and it begs to append the following particulars as to its dimensions, &c.

1. *Material.*—The Screen is constructed throughout of the best yellow pine, and all its different parts are put together with tenons, mortices, and brass screws, with the exception of the louvres, which are fastened together and secured in their places by brass rivets.

2. *Dimensions.*—Its clear internal dimensions are:—Length, 18 ins., width, 11 ins., and height, 15 ins.

3. *Framework.*—This consists of four corner posts, connected above and below by rails.

The two front posts are 1½ in. square, 20½ ins. long, and 19½ ins. apart; the two back posts are 1½ in. square, 19½ ins. long, and 19½ ins. apart.

The clear distance between the front and back posts is 12¾ ins. The under sides of the lower rails are all 1½ in. above the bottom ends of the corner posts, and 1½ in. square in section. The upper rails are 1½ in. wide and 1 in. deep, and the clear space between the upper and lower rails measures 14 ins.

4. *Louvres.*—The Screen has double louvres. The outer louvres are 2 ins. wide and ¼ in. thick. The inner louvres are 1 in. wide, and ¼ in. thick. The double louvres are formed by nailing the inner louvres to the outer, in the manner indicated in the accompanying sketch (Fig. 1). The double louvres (or rather the outer louvres) are slipped into shallow grooves, ¼ in. wide, cut in the inner sides of the four corner posts of the screen at an angle of 45° and ½ in. apart (*i.e.* ¾ in. from centre to centre, measured square to the groove).

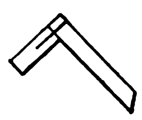


Fig. 1.

At the two back inner corners of the screen the louvres are roughly mitred.

The external edges of the outer louvres are cut off so as to make them flush with the corner posts.

5. *Door.*—The door, which forms one of the longer sides of the screen, is a rectangular frame of 1½ in. × 1 in. material, fitted with double louvres similar to those above described. It is hung by its outer bottom edge to the lower front rail by two strong brass butt hinges, and closes with its outer surface flush with the corner posts. The door is fastened with a brass hasp, staple, and padlock.

6. *Bottom of Screen.*—This is formed by three ½ in. boards, 4 ins. wide, arranged longitudinally across the lower part of the screen as follows:—The centre or upper board is let in at each end flush with the top of the lower side rails, while the other two are screwed at the ends to the under side of these same rails, in such a way that one overlaps the back, and the other the front of the centre board by ½ in. (Fig. 2).

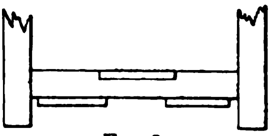


FIG. 2.

7. *Roof.*—The roof is double. The inner roof is a board ¾ in. thick, resting upon the upper rails, and cut away to receive the corner posts. It has ten 1 in. holes, drilled in it at equal distances all round, 2 ins. from the edge, as shown in the sketch (Fig. 3).

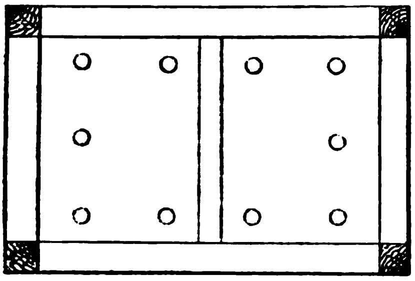


FIG. 3.

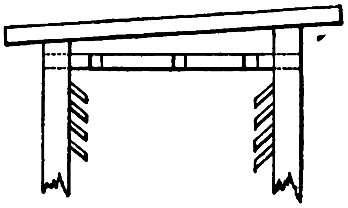


FIG. 4.

The outer roof is a 1 in. board screwed on to the top of the corner posts, and also to a narrow bearing of wood ¾ in. wide, running across the centre of the inner roof from front to back. Its under side is 1½ in. above the inner roof in front, and ½ in. above it at the back, and projects 2 ins. beyond the sides of the screen all round—thus leaving a clear space between the two roofs (Fig. 4). In order to partly close the 1¼ in. space in front, a small lath ¾ in. wide and ½ in. thick is fastened across the centre of it.

8. *Position of Thermometers.*—The position of the thermometers in the screen is to be the same as described in the *Hints to Meteorological Observers*, page 10.

The upright for the dry and wet bulb thermometers, which is 2½ ins. wide and ½ in. thick, is let into the middle of the back of the centre bottom board; and those for the maximum and minimum thermometers are

screwed to the front of it. The upper ends of these uprights are screwed to a fillet attached to the under side of the inner roof.

9. *Painting.*—Previous to being put together, all the different parts should be painted with two coats of white lead paint; and when completed, the whole screen should receive a finishing coat composed of white zinc paint and copal varnish.

APPENDIX II.

Report of the Assistant Secretary on the Inspection of the Stations during 1883.

Aberystwith, *July* 16.—This station was established by the Town Council in 1875, when the observations were promised to the Society. For some reason or other no returns were ever forwarded. I called upon Mr. Morris Jones, the Medical Officer of Health, who still carries on the observations, and arranged with him for the climatological returns to be filled up and forwarded to the Society. In order to secure the records from January 1st, I copied out, while there, the observations for the first six months of 1883, which have been printed in the *Meteorological Record*, but unfortunately, no further returns have been received. The instruments were in the same position as described in Vol. III. p. 53, and were in fairly good condition. A good deputy is required, as, owing to the observer being sometimes absent, there are occasional omissions in the record.—*Observer*, Morris Jones.

Alnwick, *August* 23.—The instruments were in good order. The barometer being in a small wooden shed and subject to a considerable range of temperature during the day, the observer was requested to remove it to a room in his house.—*Observer*, J. Lingwood, F.R.Met.Soc.

Belper, *July* 20.—The thermometers were in good condition; the screen, however, required painting. The position is not very satisfactory, as it is rather confined by trees. The thermometric readings are made by the Misses Hunter. The rain-gauge was moved to a garden in the Matlock Road in April, 1882. As the exposure was very confined, one tree on the south-east subtending an angle of 58°, and another on the north 45°, the observer was requested to move the gauge on August 1st, fifteen feet further south-west, where the objects would only subtend an angle of about 25°.—*Observer*, J. Hunter, Junr., Assoc.M.Inst.C.E., F.R.Met.Soc.

Blackpool, *August* 14.—All the instruments were in good condition, and the observations appear to be very carefully made. The sunshine recorder, which has been obtained since the last inspection, is placed on the south-west corner of a wooden building at the end of the North Pier.—*Observer*, C. T. Ward, B.A., F.R.Met.Soc.

Bolton, *August* 13.—This station is at Belmont Road, Sharples, nearly three miles from Bolton. The ground slopes from north-west to south-east;

that on the north-west rising to a considerable altitude. A large reservoir lies to the north-west of the garden in which the instruments are placed; the south-east bank, which is fifty feet high, being only about 200 or 300 feet distant. The thermometer screen is a home-made one,—in fact there are two screens, one inside the other, both having single louvres. There is a board at the back of the inner screen, to which the thermometers are fastened. The bulbs of the maximum and minimum were close to this board, so that there was not free circulation of air round them. The bulbs of the dry and wet were almost touching the board at the bottom of the screen. The minimum had been oiled all over, and was in a dirty condition. A rearrangement of the instruments was recommended, pending the adoption of the new pattern screen by the Society. The thermometers had not been verified since 1860; and on comparison their zeros were found to have altered as follows:—Maximum $+0^{\circ}\cdot9$, Minimum $-0^{\circ}\cdot8$, Dry $+0^{\circ}\cdot6$, Wet $+0^{\circ}\cdot3$, Grass Minimum $-5^{\circ}\cdot0$. The subsoil is clay.—*Observer*, REV. T. MACKERETH, F.R.Met.Soc.

BOSTON, *July* 21.—Owing to the serious illness of Mr. Hackford, the special observations at this station have not been regularly carried on. (Mr. Hackford died February 20th, 1884.)

BURGHILL, *July* 12.—Since the last inspection a new rain-gauge has been obtained, and placed in a more open position than the old one, which is still observed. The instruments were in good order, but the thermometer screen required painting.—*Observer*, T. A. CHAPMAN, M.D.

BUXTON, *July* 19.—During the progress of the alterations at the Devonshire Hospital the instruments have been occasionally moved. They are now permanently fixed in their new positions. The barometer, which had given too high readings, was sent to London on June 1st for repair and re-verification, and returned on July 17th. A sunshine recorder has been obtained since the last inspection.—*Observer*, E. J. SYKES, M.B., F.R.Met.Soc.

CARDIFF, *July* 14.—The exposure at this station, which is not very good, is becoming still more confined owing to the erection of the new Public Hall about seventy feet off on the south-east. The thermometer screen required painting.—*Observer*, W. ADAMS, F.R.Met.Soc.

CARMARTHEN, *July* 14.—This station was in good order. On comparing the thermometer it was found that the zero of the dry bulb has risen $0^{\circ}\cdot1$, and that of the wet bulb $0^{\circ}\cdot3$. Dr. Hearder will most probably obtain one of the new pattern screens when it has been adopted by the Society.—*Observer*, G. J. HEARDER, M.D.

CHEADLE, *July* 18.—The observer and his deputies were away at the time of my visit, but the instruments appeared to be in good order. The muslin on the wet bulb, however, required changing, and the thermometer screen painting.—*Observer*, J. C. PHILIPS, J.P.

CHESTER, *July* 17.—The thermometers were in good order, but the screen required painting.—*Observer*, A. O. WALKER, F.L.S.

CRAMLINGTON, *August* 23.—This station is nine miles north of Newcastle, seven miles south of Morpeth, and four miles from the sea-coast. The instruments are placed on a grass plot in the vegetable garden; the exposure

is quite open from east-south-east to west, but there are some trees rather near on the north to east. As the rain-gauge was somewhat sheltered by these trees, a more open site was selected for it. The ground is level, and is only slightly undulating in the district. The subsoil is clay on stone, with coal below.—*Observer*, W. BONALLO, F.R.Met.Soc.

KENILWORTH, *July* 11.—This station was in good order. As Mr. Slade removed from Kenilworth at the end of August arrangements were subsequently made with Mr. S. Forrest for continuing the observations at Ladye's Hill. —*Observer*, F. SLADE, F.R.Met.Soc.

LEATON, *July* 17.—The observer was away from home at the time of my visit, but the butler was left in charge of the instruments. He had, however, unfortunately not received sufficient instruction, and was therefore not making accurate observations. If he were properly trained, he would make an excellent observer, and the records would be more complete than they have hitherto been. The thermometer screen required painting.—*Observer*, Rev. E. V. PIGOTT, M.A., F.R.Met.Soc.

LLANDUDNO, *July* 17.—The instruments were all in good order. The barometer had been sent to the maker, and cleaned since the last inspection. Dr. Nicol has recently started another (larger) thermometer screen, and a 5 in.Snowdon rain-gauge in a vegetable garden on the other side of the road in front of his house, where there is a very open exposure. The results agree very closely with those from the other instruments.—*Observer*, J. NICOL, M.D., F.R.Met.Soc.

MACCLESFIELD, *July* 19.—The thermometer screen until about a fortnight before my visit had been painted green; it is now painted white. The instruments were in good order.—*Observer*, J. DALE, F.R.Met.Soc.

OAKAMOOR, *July* 18.—The instruments were all correct. Owing doubtless to the lack of proper instruction, the observer appeared to have been liable to read the thermometers somewhat erroneously. I believe that in future the readings will be taken more carefully.—*Observer*, G. WILLIAMS.

OLD STREET, LONDON, *July* 4.—This station, as explained in the Report of the Council for 1882,[1] is at St. Luke's Churchyard, Old Street. The instruments are on the south side of the church and very well exposed. Owing to the dusty state of the neighbourhood, the screen soon gets very dirty; it will, however, be painted as frequently as possible.—*Observer*, REV. A. P. HOCKIN.

ROSS, *July* 13.—The covering for the wet-bulb was very dirty, and had not been changed for a long while. In other respects the instruments were in good order. Young rose trees are, however, growing up near the rain-gauge, and will require to be kept down.—*Observer*, H. SOUTHALL, F.R.Met.Soc.

ROUNTON, *August* 24.—As the barometer was placed in a corridor exposed to the full morning sun, I requested that it might be removed to the end of the corridor which faces north, where the range of temperature would be

[1] *Quarterly Journal*, Vol. IX. p. 86.

small. All the other instruments are placed in an enclosure twenty feet in diameter in a large open field. The ground is level, but slightly undulating in the district. The instruments were all in good order. The subsoil is clay.—*Observer*, I. LOWTHIAN BELL, F.R.S., F.R.Met.Soc.

SCALEBY, *August* 20.—The exposure is more open than at the last inspection, as a number of trees have been cut down. The wet-bulb thermometer was not in good order, as the muslin was almost dry, and covered with incrustation of lime. The maximum was hung by a string, and liable to be shaken by the wind. I readjusted this thermometer, and also put up a spare maximum.—*Observer*, R. A. ALLISON, F.R.Met.Soc.

SCARBOROUGH, *August* 24.—All the instruments were in good order, but on comparing the thermometers it was found that the minimum read 0°·5 too high.—*Observer*, A ROWNTREE, F.R.Met.Soc.

SEATHWAITE, *August* 16.—The spare maximum thermometer had not been working satisfactorily, as it was mounted with the bulb higher than the other end. This I remedied by altering its position. All the other instruments were in good order.—*Observer*, W. DIXON.

STAPLETON, *August* 20.—The minimum thermometer had a little spirit at the top of the tube, but all the other instruments were in good condition. The thermometer screen needed painting.—*Observer*, A. W. STIRLING, M.B., F.R.Met.Soc.

ST. MICHAEL'S-ON-WYRE, *August* 14.—The maximum thermometer got out of order at the end of 1882, but was sent to the maker to be set right; it is now in good working order. All the other instruments were in a satisfactory state.—*Observer*, REV. P. J. HORNBY.

STRELLEY, *July* 20.—This station was in a satisfactory condition.—*Observer*, T. L. K. EDGE, F.R.Met.Soc.

WAKEFIELD, *August* 25.—This station was inspected last in 1878. On comparing the thermometers it was found that all their zeros had changed, the maximum having increased as much as 0°·4. The screen was nearly black, and urgently required painting. Owing to the great prevalence of smoke, the screen requires frequent painting.—*Observer*, H. CLARKE, L.R.C.P., F.R.Met.Soc.

APPEN-

ABSTRACT OF RECEIPTS AND EXPENDITURE

RECEIPTS.

	£	s.	d.	£	s.	d.
Balance from 1882				173	11	6
Dividend on £800 M. S. and L. R. 4½ Debenture Stock	35	0	7			
Do. £423 5s. 3d. New 3 per Cents.	12	7	10			
				47	8	5
Subscriptions for 1880 and former years	4	7	0			
Do. 1881	5	0	0			
Do. 1882	14	10	0			
Do. 1883	395	11	0			
Do. 1884	6	0	0			
Entrance Fees	32	2	0			
Life Compositions	180	0	0			
Donations by Life Fellows (Sir D. L. Salomons and Mr. H. S. Wallis)	19	10	0			
				657	0	0
Meteorological Office:—						
Copies of Monthly Returns	100	0	0			
Do. Annual „	2	10	0			
Do. Weekly „	4	12	0			
Grant towards Inspection Expenses	25	0	0			
				132	2	0
Sale of Publications				27	2	5
Donation by the late Mr. C. Greaves				10	0	0
				£1047	4	4

DIX III.

FOR THE YEAR ENDING DECEMBER 31ST, 1883.

EXPENDITURE.

	£	s.	d.	£	s.	d.
Journal, &c.:—						
Printing Nos. 45-48	119	9	0			
Illustrations	22	14	6			
Authors' Copies	11	4	0			
Meteorological Record, Nos. 8-10	43	7	9			
Registrar-General's Reports	8	8	0			
Type for Symbols	3	8	0			
Engraving outline Charts of N. Atlantic and British Isles	6	10	0			
				215	1	3
Printing, &c.:—						
General Printing	24	14	3			
List of Fellows and Instructions to Phenological Observers	19	4	6			
Forms	6	16	6			
Stationery	10	15	7			
Books and Bookbinding	19	11	9			
				81	2	7
Salaries:—						
Assistant-Secretary	160	0	0			
Computers	119	12	0			
				279	12	0
Office Expenses:—						
Rent and Housekeeper	48	10	4			
Furniture, Coals and Insurance	7	17	11			
Postage	45	10	3			
Refreshments	14	1	7			
Exhibition of Instruments	2	19	0			
Parcels and Petty Expenses	6	11	1			
				125	10	2
Observations:—						
Inspection of Stations	36	15	9			
Preparation of Agreement with the Rector and Churchwardens of St. Luke's, Old Street, E.C.	6	9	6			
Observers at Old Street and Seathwaite	7	2	0			
Instruments and New Pattern Stevenson Thermometer Screen	14	7	8			
				64	14	11
Stock:—						
Purchase of £36 7s. 3d. New 3 per Cents.				37	0	0
				803	0	11
Balance:—						
At Bank of England	230	2	11			
In hands of the Assistant-Secretary	14	0	6			
				244	3	5
				£1047	4	4

Examined and compared with the vouchers and found correct.

7th January, 1884.

J. S. HARDING, } *Auditors.*
H. SOWERBY WALLIS, }

APPENDIX III.—*Continued.*

Abstract of Assets and Liabilities on January 1st, 1884.

Liabilities.

	£	s.	d.
To Subscriptions for 1884 paid in advance	6	0	0
,, Excess* of Assets over Liabilitie	1820	8	9
	£1826	8	9

* This excess is exclusive of the value of the Library and Stock of Publications.

Assets.

	£	s.	d.	£	s.	d.
By Society's Money invested in New 3 per Cents., £423 5s. 3d. at 101½	428	12	0			
,, Society's Money invested in M. S. and L. R. 4½ Debenture Stock, £800 at 122	976	0	0			
				1404	12	0
,, Subscriptions unpaid, estimated at	35	0	0			
,, Entrance Fees unpaid	10	0	0			
,, Dividend on £800 M. S. and L. R. 4½ Debenture Stock	17	12	6			
,, Meteorological Office—Weekly Returns 1883	5	0	10			
				67	13	4
,, Furniture, Fittings, &c.	35	0	0			
,, Instruments	75	0	0			
				110	0	0
,, Cash in hands of Bank of England	230	2	11			
,, Do. the Assistant-Secretary	14	0	6			
				244	3	5
				£1826	8	9

J. S. HARDING,
H. SOWERBY WALLIS, } *Auditors.*

WILLIAM MARRIOTT, *Assistant-Secretary.*

7th January, 1884.

APPENDIX IV.

Obituary Notices.

Mr. Charles Greaves was the eldest son of Charles Greaves, of St. Paul's Churchyard, and Charlotte, daughter of Robert Mylne, the architect of Old Blackfriars Bridge, who was for nearly fifty years surveyor to St. Paul's Cathedral, and engineer to the New River Company. He spent his early boyhood on Dartmoor, and was educated first at Cheam School, under Dr. Mayo, and afterwards, on his family removing to Devonport, under the Rev. H. A. Greaves, his father's cousin, who had recently been appointed head master of the Classical and Mathematical School at that place. Here he had among his fellow schoolmates Sir John Coode, Bishop Colenso, and Mr. Nathaniel Beardmore, President of the Meteorological Society in 1861, a sister of whom he married in 1851. In the autumn of 1832 he was articled Civil Engineer to Mr. J. M. Rendel. On the expiration of his pupilage, in 1837, he for some time was assistant to his uncle, Mr. W. C. Mylne, at New River Head, but soon returned to his old master Mr. Rendel. In January 1842 Mr. Greaves went to Calcutta, and practised for the next five years in Bengal, returning in 1847 to England. In 1851 he was appointed successor to Mr. Wicksteed as Engineer to the East London Waterworks Company. This he raised by unfailing energy and unremitting toil from a comparatively small undertaking to a prominent position among the great water companies of the Metropolis.

It is not the place here to enumerate the extensive engineering works carried out by him in this connection. The main point of interest to the meteorologist is to place on record the fact that he was the first to recognise the importance of ascertaining the true amount of evaporation from large bodies of water. This he determined approximately by establishing in 1859 a gauge 1 yard square and 1 foot deep, which was kept afloat and partially immersed in a quiet part of a stream on the premises of the East London Waterworks, at Lea Bridge. The surface of the water within was kept from 8 to 7 inches below that of the water without. It was exposed to all weathers and any addition or abstraction of water was duly recorded, none being made without necessity. By combining together the observations in the ordinary closed rain-gauge and those of the floating gauge, an absolute measure of evaporation from a water surface representing as nearly as possible the surface of a river, lake or reservoir, is obtained. He also established at the same place a series of "Dalton gauges" for finding the percolation of the rain through various soils, the first of which was set in 1851.

In 1875 Mr. Greaves retired from the more active duties of Resident Engineer, and became Consulting Engineer to the East London Waterworks Company. He was elected a Fellow of the Society on the 11th of March, 1851, became a Member of Council in 1860, and again occupied a seat at the Council table in 1877. In the year 1878 he was elected President, which post he held for two years, and from this time he devoted his attention almost exclusively to meteorological studies. In the summer of 1878 he went the round of, and inspected, the Society's stations; and in the autumn

of the same year arranged for and bore the expense of a course of six Lectures on Meteorology, which he subsequently published in a volume entitled *Modern Meteorology*.

Mr. Greaves, while pursuing his meteorological investigations, at a later date became strongly impressed with the important influence on climate resulting from the distribution of aqueous vapour, and studied with deep interest hygrometry and other kindred matters having reference to rain, and the formation and condensation of vapour in the air by changes of temperature. With this object he constructed charts showing lines of equal moisture, which he maintained were as much needed in meteorology as isobaric lines. In studying hygrometry he had in view an important object toward the accomplishment of which this branch of meteorology greatly aided him. Having allotted all available rainfall stations to their respective watersheds, Mr. Greaves was enabled to compute the probable quantity of water deposited on the various watersheds, and the approximate discharge of their respective rivers. But in order to arrive at a more exact estimate of water available, Mr. Greaves conceived the idea of estimating by percolation experiments, carried out by himself and others, the water absorbed by the soil, and also the amount lost by evaporation, and by these means of making a nearer approach to the exact volumes of water discharged by the various rivers after percolation and evaporation had taken place. To hygrometry Mr. Greaves looked for assistance in the computation of the amount of evaporation from water, and turned his attention to obtaining the vapour tension of the air and the vapour tension due to the temperature of the water. The deduction of the former from the latter gave a computable value which he termed "tensional difference," and this eventually was shown to bear a definite proportionate relation to the actual amount of evaporation from water. Mr. Greaves contended that the rate of evaporation from water did not result principally from dryness of the air, but was in a material degree owing to what has been already referred to as tensional difference.

Mr. Greaves was a Vice-President of the Society in 1880 and 1881, but retired from the Council in the latter year on going to live at Sunhill, Clevedon, in Somerset. Here he died of heart disease after six months' illness, on the 6th of November 1883, greatly regretted by the many friends which his unfailing generosity, his kindly manner, and genial ways had secured.

Sir Charles William Siemens, D.C.L., LL.D., F.R.S., &c., was only elected into the Society on March 21st, 1883, and died on November 19th of the same year. It would be impossible and inappropriate to attempt to sketch here the history of the remarkable life which began at the little town of Lenthe in Hanover on April 4th, 1823, and ended to the regret of tens of thousands in November 1883. It would be almost equally impracticable to give even a catalogue of his inventions; but, diverse as they at first appear, each and all are covered by the definition "applications of physical science to the practical needs of mankind." Siemens was an exceptionally good physicist, engineer, and man of business; and to the combination of these qualities his remarkable

success was due. Sir William had not given much attention to meteorology until the last year or two of his life. His knowledge of the varying resistance offered by the same wire at different temperatures led to the invention of Siemens's electrical thermometer, of which a full description is given in the *Journal of the Society of Telegraph Engineers*, Vol. III. (1874), p. 296, and of which he presented a beautiful specimen to this Society for use on the tower of Boston Church, as described in the *Quarterly Journal*, Vol. IX. p. 83. During the autumn preceding his greatly regretted death Sir William began a series of experiments upon anemometers, and was studying the action of Robinson's cups within a short time before he passed away.

PROFESSOR HENRY JOHN STEPHEN SMITH, F.R.S., of whom, if of any one, it could with truth be said "*nihil tetigit quod non ornavit*," could hardly be classed among active meteorologists, as his chief connection with the science arose from the official position of Chairman of the Meteorological Council, which he held from June 1877 until his unexpected death in February 1883.

That, however, he had studied the subject thoroughly at an earlier period, was sufficiently evident from the questions put by him to several witnesses before the Royal Commission on Scientific Instruction in 1870; and when, as a result of the Treasury inquiry into the Meteorological Office in 1876, it was determined to appoint a council of management, Prof. Smith was selected as the most fitting chairman.

There could not have been a better appointment. He at once threw himself into his new duties with painstaking energy, and gained the personal affection of every one who came under his influence. As to the business of the Council, the meetings were generally held at fortnightly intervals, and in each alternate week he usually devoted an entire day to the office business, coming up specially from Oxford for the purpose. He never missed a meeting during his Presidency, and never attended one without a long and careful previous study of the agenda, and an equally careful subsequent examination of the minutes before they were sent to press.

As representative of the Council, he attended the International Meteorological Congress at Rome in 1879, where his extreme courtesy, combined with unerring tact, were acknowledged on all hands to have been most important factors in the carrying to a successful issue of more than one delicate negotiation which arose during the proceedings.

The pages of this Journal are hardly a fitting place to notice his transcendent mathematical or classical attainments, which have been dealt with elsewhere, and which place him among the most remarkable men of the century; but we may quote the closing words of his obituary notice in the *Athenæum*:—"No one, probably, has ever had a larger circle of private friends to lament his loss. He had all the gifts which win and preserve attachment; not only sincerity, constancy, depth of feeling, and liveliness of sympathy, but a sweetness and nobility of nature to which no words can render adequate testimony."

He died after a short illness on the 9th February, 1883, at the age of 56; leaving an only sister to bewail his loss.

APPENDIX V.

LIST OF BOOKS PURCHASED.

BRITISH ASSOCIATION.—Report for 1875. 8vo. (1876.)
COMPANION TO THE WEATHER GLASS. (1796.)
DE FONVIELLE, W.—Thunder and Lightning. 8vo. (1868.)
DU BOULAY, T.—The Summer of 1862. 8vo. (1862.)
ENCYCLOPÆDIA BRITANNICA, Ninth Edition, Vols. XV. and XVI. 4to. (1883.)
HARRIS, SIR W. S., F.R.S.—A Treatise on Frictional Electricity. (8vo.) (1867.)
JORDAN, W. L.—The Elements. Vol. I. 8vo. (1866.)
————.—The Winds and their Story of the World. 8vo. (1877.)
LEIGH, J.—Directions for insuring personal safety during Storms of Thunder and Lightning. 12mo.
LONDON MEDICAL RECORD.—Where to take a Holiday. 4to. (1883.)
METEOROLOGICAL TRACTS (Miscellaneous). Collected by the late C. V. Walker, F.R.S. Three Vols.
MURRAY, J.—A Treatise on Atmospherical Electricity. 12mo. (1830.)
PROUT, DR. W., F.R.S.—Chemistry, Meteorology, and the Function of Digestion considered with reference to Natural Theology. 8vo. (1834.)
RHIND, A. H.—Egypt; its Climate, &c. 8vo. (1856.)
SCOTT, R. H., F.R.S.—Meteorology at Home and Abroad. (Longman's Magazine.) 8vo. (1883.)
THE SCIENCE OF THE WEATHER in a Series of Letters and Essays. Edited by "B." 8vo. (1867.)
"TIMES" REGISTER OF EVENTS in 1882. 8vo. (1883.)
TOMLINSON, C., F.R.S.—The Frozen Stream. 8vo. (1862.)
————.—The Rain-Cloud and the Snow-Storm. 8vo. (1875.)
————.—The Tempest. 8vo. (1861.)
ULLIAC-TREMADEURE, MDLLE.—Astronomie et Météorologie. 8vo. (1855.)
USILL, G. W.—Statistics of the Water Supply of the principal Cities and Towns in Great Britain and Ireland. 4to. (1881.)
VARENIUS, DR. B.—A Complete System of General Geography. Two Vols. 8vo. (1765.)

APPENDIX VI.

DONATIONS RECEIVED FROM JANUARY 1ST, TO DECEMBER 31ST, 1883.

Presented by Societies, Institutions, &c.

ADELAIDE, OBSERVATORY.—Meteorological Observations, 1880.
ADELAIDE, ROYAL SOCIETY OF SOUTH AUSTRALIA.—Transactions, and Proceedings, and Report, Vols. IV. and V., 1880 to 1882.
BATAVIA, OBSERVATORY.—Rainfall in the East Indian Archipelago, 1882.
BERLIN, K. PREUSSISCHE STATISTISCHEN BUREAU.—Preussische Statistik, LXXI., Ergebnisse der meteorologischen Beobachtungen im Jahre, 1882.—Ueber den jährlichen Gang der Temperatur in Norddeutschland. By Dr. G. Hellmann.
BOMBAY, METEOROLOGICAL OFFICE.—Brief Sketch of the Meteorology of the Bombay Presidency in 1881.
BRISBANE, GENERAL REGISTER OFFICE.—Report on the Vital Statistics, Oct. 1882, to

Sept. 1883.—Vital Statistics, 1882. Twenty-third Annual Report by the Registrar-General.

Brussels, L'Académie Royale des Sciences.—Annuaire, 1882, 1883.—Bulletins. 3me Séries, Tomes I.-V.

Brussels, L'Observatoire Royal.—Annuaire, 1883.—Bulletin Météorologique, Dec. 1882 to Nov. 1883.

Cairo, Société Khédiviale de Géographie.—Bulletin, Série II., Nos. 2 to 4.

Calcutta, Meteorological Office.—Indian Meteorological Memoirs, Vol. II., Part 1.—Registers of Original Observations reduced and corrected, Jan. 1882 to Feb. 1883. —Report on the Administration of the Meteorological Department of the Government of India in 1881-82.—Report on the Meteorology of India in 1881. By H. F. Blanford, F.R.S.

Calcutta, St. Xavier's College Observatory.—Meteorological Observations, July 1882 to June 1883.

Cape Town, Meteorological Commission.—Report for the year 1882.

Cape Town, South African Philosophical Society.—Transactions, Vol. II. Part 3.

Christiania, Editing Committee of the Norwegian North-Atlantic Expedition, 1876-1878.—Chemistry, I. On Solid Matter in Sea-water. II. On Oceanic Deposits. By L. Schmelck.—Meteorology. By H. Mohn.—Zoology. Mollusca, I. Buccinidæ. By H. Friele.

Christiania, Norske Meteorologiske Institut.—Jahrbuch für 1882.—Oversigt over Veirforholdene i Norge i Aaret 1882.

Copenhagen, Danske Meteorologiske Institut.—Annuaire Météorologique, 1880, Part 2, and 1881.—Bulletin Météorologique du Nord, Dec. 1882 to Nov. 1883.

Cordoba, Oficina Meteorológica Argentina.—Anales, Tomo III.

Cracow, K. K. Sternwarte.—Meteorologische Beobachtungen, Nov. 1882 to Oct. 1883.

Dublin, General Register Office.—Eighteenth and Nineteenth Detailed Annual Reports of the Registrar-General of Marriages, Births, and Deaths in Ireland, 1881 and 1882.—Weekly Returns of Births and Deaths, Vol. XIX. No. 51 to Vol. XX. No. 51.

Dublin, Royal Dublin Society.—Scientific Proceedings, Vol. III. New Series, Part 5.—Scientific Transactions, Vol. I. Series II. Parts 15 to 19, Vol. II Part 2.

Dublin, Royal Irish Academy.—Proceedings, Polite Literature and Antiquities, Vol. II. Ser. II. No. 4; Science, Vol. III. Ser. II. Nos. 9 and 10.—Transactions, Polite Literature and Antiquities, Part 5; Science, Parts 11 to 13.

Edinburgh, General Register Office.—Quarterly Returns of the Births, Deaths, and Marriages registered in Scotland for the four quarters ending Sept. 30th, 1883.—Supplement to the Monthly and Quarterly Returns, 1882.

Falmouth, Royal Cornwall Polytechnic Society.—The Fiftieth and Jubilee Report, 1882.

Fiume, I. R. Accademia di Marina.—Meteorological Observations. Nov. 1882 to Oct. 1883.

Geneva, Société de Géographie.—Le Globe, 4me Série. Bulletin, Tome I. No. 4 to Tome II. No. 2. Mémoires, Nos. 1 to 3.—Travaux de l'Association des Sociétés Suisses de Géographie dans sa deuxième session à Genève le 29, 30, et 31 Août, 1882.

Greenwich, Royal Observatory.—Report of the Astronomer-Royal to the Board of Visitors, 1883.—Results of the Magnetical and Meteorological Observations, 1881.

Hamburg, Deutsche Seewarte.—Monatliche Uebersicht der Witterung, July 1882 to March 1883.—Wetterbericht, 1883.

Kew, Observatory.—Reports of the Kew Committee for the years ending Oct. 31, 1882, and 1883.

Leipzig, Königl. Sächs. Meteorologische Institut.—Jahrbuch, 1883, Erste Lieferung.

León, Observatorio del Colegio.—Resumen de las Observaciones Meteorologicas. Nov. 1882 to Feb. 1883.

Lisbon, Sociedade de Geographia.—Boletin, 3a Série, Nos. 6, 7, 10 to 12, and 4a Serie, Nos. 1 to 3.—Expediçao Scientifica á Serra da Estrella em 1881, Secçao de Meteorologia, relatorio do Sr. A. C. da Silva; Secçao de Botanica, relatorio do Sr. Dr. J. A. Henriques.—La Question du Zaire.—Les Institutions de Prévoyance du Portugal par C. Goodolphim.

London, Art Union.—Reports of the Council for the years 1882 and 1883.

London, General Register Office.—Annual Summary of Births, Deaths, and causes of death in London and other great towns, 1882.—Quarterly Returns of Marriages, Births, and Deaths, for the four quarters ending Sept. 30th, 1883.—Weekly Returns of Births and Deaths, Vol. XLIII., No. 52, to Vol. XLIV., No. 51.

London, India Office.—Account of the Operations of the Great Trigonometrical Survey of India, Vols. VII. to IX.

London, Meteorological Office.—Abstract of Meteorological Register for 1880 to

1882, at Prince Edward Island.—Annaes do Observatorio do Infante d. Luiz, Lisbon, 1879.—Annual Reports of the Trustees of the New York State Library, 1880-82.—A Sailing Directory for the Ethiopic or South Atlantic Ocean. By A. G. Findlay.—Bidrag till Kannedom af Finlands Natur och Folk utgifna af Finska Vetenskaps-Societeten. Häftet 37 and 38.—British Storms. By T. Stevenson.—Bulletin quotidien de l'Algérie, Dec. 16, 1882, to Nov. 15, 1883.—Calculations of Densities and Expansions, No. 6.—Charts of Winds and Currents in the Gulf of Guinea.—Daily Weather Reports, 1882.—Daily Weather Reports of the Revenue and Agricultural Department, India, Jan. 1, 1881, to June 30, 1883.—Die Bahnbestimmung der Wirbelstürme durch Normalörter. Von E. Knipping.—Hansa, Vol. XI. No. 16.—Hourly Readings, April 1881 to March 1882.—Jahrbuch der meteorologischen Beobachtungen der Wetterwarte der Magdeburgischen Zeitung, 1881 und 1882.—La Riforma Gregoriana del Calendario. Dal P. G. S. Ferrari.—Lieut. Fergusson's Charts of Winds and Currents in the Red Sea and Gulf of Aden.—Meteorological Atlas of the British Isles.—Meteorological Observations made at Hiroshima and Osaka, Japan, July to Dec. 1882.—Meteorological Observations taken at Southport, April 15, 1882, to Oct. 5, 1883.—Meteorological Observations taken at the Imperial Meteorological Observatory, Tokio, Japan, June to Oct. 1882.—Normalörter für die Taifune in den chinesischen und japanischen Gewässern des Jahres 1880. Von E. Knipping.—Note on the Report on the Meteorology of Kerguelen Island, published by the Meteorological Council, 1879.—Note sur certaines Tempêtes Hivernales de l'Algérie, par Prof. J. Fourniet.—Observations Météorologiques du Réseau Africain, Année 1880.—Observations Météorologiques faites à Saint-Martin-de-Hinx, France, par H. Carlier, Dec. 1881 to Nov. 1882.—Postos Meteorologicos, July to Dec. 1877, and Jan. to Dec. 1880.—Rainfall Tables of the British Isles for 1866 to 1880.—Report of the Second Meeting of the International Meteorological Committee, held at Copenhagen, August 1882.—Reports of the Astronomer-Royal for Scotland to the Board of Visitors at the Royal Observatory, Edinburgh, for 1852, 1858, 1861, and 1862.—Siebenundsechszigster Jahresbericht der naturforschenden Gesellschaft in Emden, 1881-82.—Singapore Meteorological Returns, 1881.—Sulla Rifrazione. Memoria di A. Dorna.—Sunshine Records of the United Kingdom for 1881.—The Mean Pressure of the Atmosphere over the Globe, Part I. January, July, and the Year. By A. Buchan.—The Meteorology of Ceylon in 1881.—The Quarterly Weather Report, 1876, Part II., and 1877 and 1880, Appendices and Plates.—The Regulation of the Waters of the Jura. By C. de Graffenried.—The Winds of the Globe. By Prof. J. H. Coffin.—United States. Report of the Commissioner of Agriculture for 1881 and 1882.—Weekly Weather Reports, Vol. V. No. 51 to Vol. VI. No. 51.

London, Royal Agricultural Society.—Journal. New Series, Vol. XIX.

London, Royal Astronomical Society. Monthly Notices. Vol. XLIII. No. 2, to Vol. XLIV. No. 1.

London, Royal Botanic Society.—Quarterly Record, Nos. 12 to 15.

London, Royal Institution of Great Britain.—Proceedings, No. 75.

London, Royal Society.—Proceedings, Nos. 222 to 226.

London, Sanitary Institute of Great Britain.—Transactions, Vol. IV.

London, Society of Arts.—Journal, Nos. 1572 to 1623.

London, Society of Public Analysts.—The Analyst. Jan. to Nov. 1883.

London, Society of Telegraph Engineers and of Electricians.—Journal, Nos. 45 to 49.—List of Members, 1883.

London, War Office.—Army Medical Department Report for the year 1881.

Madrid, Sociedad Geografica.—Boletin. Tomo XIII. No. 6, to Tomo XV. No. 3.

Marlborough College Natural History Society.—Report for 1882.

Melbourne, Observatory.—Monthly Record of Results of Observations in Meteorology, Terrestrial Magnetism, &c., Jan. 1882 to June 1883.

Melbourne, Royal Society of Victoria.—Transactions and Proceedings. Vol. XIX.

Mexico, Ministerio de Fomento.—Boletin. Tomo VII. No. 96 to Tomo VIII. No. 189.—Revista Cientifica Mexicana. Tomo I., Nos. 24 and 25.—Revista Mensual Climatologica. Tomo I. No. 14 to Tomo II. No. 2.

Michigan, State Board of Health.—Meteorological Reports from Observations made at the State Capitol, Lansing, Dec. 10, 1882, to Dec. 1, 1883.—Michigan Crop Report, Dec. 1882 to May, and July to Nov. 1883.—Tenth Annual Report of the Secretary for the fiscal year ending Sept. 30, 1882.

Milan, Reale Osservatorio di Brera.—Metodo di Hansen per Calcolare le Perturbazioni dei Piccoli Pianeti intieramente rifuso ed originalmente esposto, da Prof. A. Venturi.—Osservazioni Meteorologiche Orarie ottenute da Strumenti Registratori durante l' anno 1881. Rilevate e Calcolate da C. Fornioni.—Sui Temporali osservati nell' Italia superiore durante l' anno 1878.

Milan, R. Specola di Brera.—Osservazioni Meteorologiche, 1882.

Missouri, Weather Service.—Notes on American Earthquakes. No. 12. By Prof. C. G. Rockwood.

Moncalieri, Associazione Meteorologica Italiana.—Bollettino Decadico pubblicato

per cura dell' Osservatorio Centrale del Reale Collegio Carlo Alberto in Moncalieri, Aug. 1882 to July 1883.—Bollettino Mensuale pubblicato per cura dell' Osservatorio del Real Collegio Carlo Alberto in Moncalieri. Serie II. Vol. II. No. 7 to Vol. III. No. 8.

MONCALIERI, OSSERVATORIO R. C. CARLO ALBERTO.—I Assemblea Generale dell' Associazione Meteorologica Italiana nella Citta di Napoli, dal 25 Sept.—1 Oct. 1882.

MUNICH, K. B. METEOROLOGISCHE CENTRAL-STATION.—Beobachtungen der meteorologischen Stationen im Kon. Bayern, Jahrgang IV. Heft 3 to Jahrgang V. Heft 2.—Uebersicht über die Witterungsverhältnisse im Kon. Bayern, Nov. 1882 to Nov. 1883.

MUNICH, K. STERNWARTE.—Meteorologische und magnetische Beobachtungen, 1882.

NEW YORK, CENTRAL PARK OBSERVATORY.—Abstracts of Registers from Self-Recording Instruments, Nov. 1882 to Oct. 1883.

PARIS, BUREAU CENTRAL MÉTÉOROLOGIQUE DE FRANCE.—Annales, 1877; 1879, Parts 2 and 3; and 1880, Parts 1 to 4.—Bulletin International, 1883.

PARIS, L'OBSERVATOIRE DE MONTSOURIS.—Annuaire, 1883.

PARIS, SOCIÉTÉ MÉTÉOROLOGIQUE DE FRANCE.—Annuaire, March to Oct. 1882; and Jan. to Aug. 1883.

PHILADELPHIA, AMERICAN PHILOSOPHICAL SOCIETY.—Proceedings, Nos. 110 to 112.

PRAGUE, K. K. STERNWARTE.—Astronomische, magnetische und meteorologische Beobachtungen. 1882.

RIO DE JANEIRO, L'OBSERVATOIRE IMPERIAL.—Annales. Tome I., Description de l'Observatoire.—Bulletin Astronomique et Météorologique, Oct. 1882 to Sept. 1883.

ROME, UFFICIO CENTRALE DI METEOROLOGIA ITALIANA.—Annali, Serie II., Vol. III., 1881; Bollettino Mensile, July 1881 to May 1882.

ROTTERDAM, SOCIÉTÉ BATAVE DE PHILOSOPHIE EXPÉRIMENTALE.—Programme, 1882.

ST. PETERSBURG, IMPERIAL ACADEMY OF SCIENCES.—Communications from the International Polar Commission. Part 4.

ST. PETERSBURG, PHYSIKALISCHES CENTRAL OBSERVATORIUM.—Annalen, 1881, Theil II.—Meteorologische Beobachtungen angestellt auf Schiffen der russischen Flotte. Band I.

SAN FERNANDO, INSTITUTO Y OBSERVATORIO DE MARINA.—Anales. Seccion 2a. Observaciones Meteorológicas, Anos 1879, 1881 and 1882.

STOCKHOLM, METEOROLOGISKA CENTRAL-ANSTALTEN.—Handledning vid Meteorologiska Observationers Anstallande af E. Edlund.

STONYHURST COLLEGE OBSERVATORY.—Results of Meteorological and Magnetical Observations, 1882.

TIFLIS, PHYSIKALISCHES OBSERVATORIUM.—Meteorologische Beobachtungen, 1881.

TOKIO, UNIVERSITY.—Measurement of the Force of Gravity at Sapporo (Yesso).

TORINO, ASSOCIAZIONE METEOROLOGICA ITALIANA.—Atti della Prima Riunione Meteorologica Italiana.

TORONTO, MAGNETIC OBSERVATORY.—General Meteorological Register, 1882.

TORONTO, METEOROLOGICAL OFFICE.—Monthly Weather Review, Nov. 1882 to Oct. 1883.—Report of the Meteorological Service of the Dominion of Canada for the year 1881.

UPSALA, OBSERVATOIRE DE L'UNIVERSITÉ.—Bulletin Météorologique Mensuel, Vol. XIV., Année 1882.—Marche des Isothermes en automne dans le nord de l'Europe. Par A. G. Högbom.

UTRECHT, K. NEDERLANDSCH METEOROLOGISCH INSTITUUT.—Meteorologisch Jaarboek voor 1882.

VIENNA, K. K. CENTRALANSTALT FÜR METEOROLOGIE UND ERDMAGNETISMUS.—Beobachtungen, Nov. 1882 to Oct. 1883.—Jahrbuch, 1879; 1880, Part 2; and 1881, Part 1.

VIENNA, OESTERREICHISCHE GESELLSCHAFT FÜR METEOROLOGIE.—Zeitschrift, Jan. to Dec. 1883.

WASHINGTON, CHIEF SIGNAL OFFICE.—Annual Report of the Chief Signal Officer for the fiscal year ending June 30, 1880.—Daily Bulletins of Weather Reports with the Synopses, Indications and Facts, Sept. to Dec. 1877.—History of the United States Signal Service.—Memoranda on International Scientific Co-operation in Meteorology, Magnetism, etc.—Monthly Weather Review, Oct. 1882 to Feb. and April to Sept. 1883.—The Use of the Spectroscope in Meteorological Observations. By W. Upton.—Work of the Signal Service in the Arctic Regions.

WASHINGTON, SMITHSONIAN INSTITUTION.—Annual Report of the Board of Regents for the year 1881.

WATFORD, HERTFORDSHIRE NATURAL HISTORY SOCIETY.—Transactions, Vol. I. Part 2, and Vol. II. Parts 2 to 6.

WELLINGTON COLLEGE, NATURAL SCIENCE SOCIETY.—Thirteenth Annual Report, 1882.

WELLINGTON, N. Z., REGISTRAR-GENERAL'S OFFICE.—Results of a Census of the Colony of New Zealand taken for the Night of the 3rd of April, 1881.—Statistics of the Colony of New Zealand for the years 1881 and 1882.

YORK, YORKSHIRE PHILOSOPHICAL SOCIETY.—Annual Report for 1882.

ZI-KA-WEI, L'OBSERVATOIRE MAGNÉTIQUE ET MÉTÉOROLOGIQUE.—Bulletin Mensuel, March and April 1883.

Presented by Individuals.

AIRY, SIR G. B., F.R.S.—Monthly Means of the Highest and Lowest Diurnal Temperatures of the Water of the Thames.

ALDRIDGE, E. G.—The Isle of Wight as a Health Resort. By J. Groves, M.B.—The Weather of March, 1883.

BARRY, Dr. F. W.—Cyprus. Report by Her Majesty's High Commissioner for 1880.—Second Annual Report of the Sanitary Commissioner with the Government of Cyprus for the year 1881.

BENTLEY, R.—Bentley's Snow Melting Rain-Gauge.

BINYON, J. B.—Rainfall at Blackrock, Co. Cork, 1865-83.—Remarks on the Weather at Blackrock, Co. Cork, in 1882. (MS.)

BOLTON, C. P.—Weather at Halfway House, Co. Waterford, 1882.

BRYAN, W. B.—Meteorological Register kept at the Honourable East India Company's Observatory at Madras, 1822-1843.—Rainfall at several Stations in the Counties of York and Lancaster, 1882.

BUCHAN, A.—Meteorology. (From the *Encyclopædia Britannica*.)

BURDER. Dr. G. F.—Thirty Years' Rainfall at Clifton.

BUSIN, P.—Misura delle altezze mediante il barometro.—Sui tipi isobarici italiani.

CASELLA, L.—List, with Notes, of Standard Meteorological Instruments for Observatories, Travellers, &c.—Tables for showing Heights, for use with an hypsometer.—The Rain-band in the Spectrum, with a few directions as to the best mode of observing it.—The Whipple-Casella Universal Sunshine Recorder.

CHISTONI, Dr. C.—Il Barometro Normale dell' Ufficio Centrale di Meteorologia Italiana confrontato con Barometri Normali e con Barometri Campioni di Instituti Scientifici Stranieri.—Misure Magnetiche eseguite in Sicilia nel 1881.

CLARK, L.—A Treatise on the Transit Instrument.

CORBETT, V. W.—On Water-Gauge, Barometer, and other observations taken at Seaham Colliery during the time the Maudlin Seam was sealed up.

DALE, J.—Foretelling the Weather.

DE BORT, L. T.—Sur l'hiver de 1879-80.

DENZA, P. F.—Amplitudine della Oscillazione Diurna della Declinazione Magnetica ottenuta all' Osservatorio del R. Collegio Carlo Alberto in Moncalieri negli anni 1879 e 1880.—Détermination des Valeurs absolues du Magnetisme Terrestre en Italie.—Intorno alla Aurora Polare del 31 gennaio 1881.—La Meteorologia e la Fisica Terrestre al III. Congresso Geografico Internazionale di Venezia.—Lois de la Variation Diurne de l'Electricité Atmosphérique à Moncalieri.—Lois Générales des Variations de l'Electricité Atmosphérique.—Organisation de l'Association Météorologique Italienne.—Sulla Connessione tra le Eclissi di Sole ed il Magnetismo Terrestre.—Variation de la Déclinaison Magnétique déduite des Observations régulières faites à Moncalieri.

DICKSON, E. B.—Weather Report for Auckland, New Zealand, during 1882.

DOYLE, P.—Prospect of Artesian Borings in the Bellary District.

EATON, H. S.—Résumé des observations météorologiques faites pendant l'année 1881, en quatre points du Haut Rhin et des Vosges. Par G. A. Hirn.

FERRARI, Dr. C.—Osservazioni dei Temporali Raccolte nel 1880 e relativo studio.

FINEMAN, C. G.—Sur la Trombe du 7 Juin 1882 dans la vallée de Säby.

FINES, Dr.—Bulletin Météorologique du Département des Pyrénées-Orientales, 1872 to 1882.—Des Froids de Décembre 1871 à Perpignan.—Différence de Température observée à la Ville et à la Campagne à Perpignan.—Météorologie et Maladies Régnants observées à Perpignan pendant l'année 1869.—Notes sur la Climatologie du Roussillon.—Vent, sa direction et sa force observées à Perpignan.

FOX, W. L.—Tables of Sea Temperature, Bright Sunshine and Climate of Falmouth for the year 1882.

GLYDE, E. E.—Abstract of Meteorological Observations made at Babbacombe, Torquay, during 1882.—Meteorological Summaries for Sept. 1882 to Oct. 1882, made at Babbacombe, Torquay.

GOSLIN, S. B.—What shall we Drink?

HALL, M.—Jamaica Rainfall from about 1870 to the end of 1879. Parts 1 and 2.—Jamaica Weather Report, Nov. 1882 to Oct. 1883.

HAMBERG, Dr. H. E.—Resumé af meteorologiska observationer i Gyda-viken i vestra Sibirien.—Sur la Variation Diurne de la Force du Vent. Part 3.

HANKINSON, R. C.—Weather at Red Lodge, Southampton, Dec. 1882 to June, and Aug. to Nov. 1883. (MS.)

HANN, Dr. J.—Bericht über die Fortschritte der geographischen Meteorologie.—Ueber die klimatischen Verhältnisse von Bosnien und der Herzegowina.

HARVEY, REV. C. W.—Rainfall in Herts, Dec. 1882 to February 1883.

HEINEKEN, THE LATE REV. N. S. (Bequest.)—Climate of Sidmouth. Tables of Daily

Max. and Min. Temperatures and Rainfall, 1868 to 1878.—Meteorological Tables for 1854, 1856 and 1863, compiled from observations taken at Wakefield Prison. By W. R. Milner.—On the Climate and Medical Topography of Sidmouth. By J. D. Jeffery.—Readings of the Rain Gauge at Well-Head, Halifax, Yorkshire, 1829 to 1861. By J. Waterhouse.—Registers of Meteorological Observations made at Sidmouth from May 1836 to Jan. 1868. (MS.)—Tables of the Climate of Sidmouth. By W. H. Cullen, M.D. —The Climate of Sidmouth. By W. H. Cullen, M.D.

Hildebrandsson, Dr. H. H.—Samling af bemärkelvedagar, tecken, märken, ordsprak och skrock rörande väderleken.—Sur la Distribution des Eléments Météorologiques autour des Minima et des Maxima Barométriques.

Hoffmann, Prof. H.—Phänologische Beobachtungen aus Mittel-europa.

Hopkinson, J.—Meteorological Observations taken at Wansford House, Watford, during 1881 and 1882.—Miscellaneous Rural Notes, 1882. By G. Roberts.—Reports on Phenological Phenomena observed in Hertfordshire during 1880 to 1882.

Hunter, J., Junr.—Weekly Summaries of Meteorological Observations at Belper, 1883.

Jackson, Louis D'A.—Simplified Weights and Measures.

Kammermann, A.—Résumé Météorologique des l'années 1881 et 1882 pour Genève et le Grand Saint-Bernard.

Laughton, J. K.—The Earth in Meteoric Shadow. By R. A. Proctor.

Lewis, C. T.—Dr. Taylor on the Climate of Pau.

Ley, Rev. W. C.—Note on a proposed scheme for observation of the Upper Clouds.

Loomis, Prof. E.—Contributions to Meteorology. Eighteenth and Nineteenth Papers.

Marcet, Dr. W., F.R.S.—Southern and Swiss Health Resorts.

Marriott, W.—The Weather and the Crops. By W. H. Eley.

Mawley, E.—The Rosarian's Year Book, 1883.—The Weather of 1882 as observed in the neighbourhood of London.—The Weather of Nov. 1882 to Oct. 1883. Meteorological Observations taken at Addiscombe, Croydon.

McLandsborough, J.—Meteorology of Bradford for 1882.

Mellish, H.—Summary of Meteorological Observations at Hodsock Priory, Worksop, 1875 to 1882. (MS.)

Merrifield, Dr. J.—Meteorological Summary for Plymouth, 1882.

Miller, S. H.—The Shipwrecked Mariner, Vol. XXIX.

Moore, A. W.—Four Years' Gales at Douglas, Isle of Man.

Murray, J.—Report on the Scientific Results of the Voyage of H.M.S. Challenger during the years 1873 to 1876. Narrative, Vol. II.

Nicholson, Dr. A. W.—Michigan and its Resources.—Some Meteorological Aspects of Ventilation.—Some of the Dangers to Health pertaining to Pioneer Life.—The Causation of Intermittent Fever.

Nicol, Dr. J.—Llandudno. (Reprint from the *London Medical Record.*)

Ormerod, Miss E. A.—Report of Observations of Injurious Insects during the year 1882, with methods of Prevention and Remedy, and Special Report on Wireworm.

Ormerod, G. W.—Rainfall at Teignmouth, 1882.

Page, Dr. H.—Meteorological Observations made at Redditch, 1880 to 1882. (MS.)

Philips, J. C.—Original Traces from Self-recording Aneroid Barometer, 1883.

Preston, Rev. T. A.—Wiltshire Rainfall, Dec. 1882 to Nov. 1883.

Prince, C. L.—Aurora Borealis of Oct. 2, 1882.—Liberti Fromondi Meteorologicorum. Libri Sex.—The Great Comet of 1882.—The Summary of a Meteorological Journal kept at Uckfield, 1848, 1852-54, 1856, 1857, 1859, 1861, 1862, 1864 and 1867; and at Crowborough Beacon, Sussex, 1874.

Ragona, Prof. D.—Andamento Annuale della Pressione Atmosferica.—Sulle ore delle Massime e Minime Velocità Assolute del Vento in Modena.—Sul Periodo Diurno della Elettricità Atmosferica e della Corrente Tellurica Ascendente.

Ramsay, A.—The Scientific Roll, Nos. 10 and 11.

Raulin, Prof. V.—Météorologie Algérienne. Sur le régime pluvial de l'Algérie pendant la période décennale 1871-80.—Observations Pluviométriques faites en France de 1871 á 1880.

Roper, W.—Statistics of Lancaster Rainfall and other Local Meteorological Information.—Weather Sayings, Proverbs and Prognostics, chiefly from North Lancashire (First and Second Editions).

Rowell, G. A.—Artificial Aurora and Production of Rain.

Saint-Martin, Capt. P.—De l'Installation du Pluviomètre.

Sawyer, F. E.—Brighton Rainfall.—St. Swithin and Rainmakers.—Sussex, Natural History, Folk-Lore and Superstitions.

Schück, Capt. A.—Mittheilungen über einen Taifun bei Yokohama und Yeddo am 8 Sept. 1860 und einen vom 18-20 Aug. 1869.

• Scott, R. H., F.R.S.—Elementary Meteorology.—Grundzüge der Meteorologie. Von Prof. H. Mohn.—Les Grandes Découvertes faites en Physique depuis la fin du XVIII^e Siécle. Par C. Montigny.—Storm Warnings.—Weather Knowledge in 1883.

Scudder, S. H.—The fossil White Ants of Colorado.

SILVER, S. W.—Catalogue of the York Gate Geographical and Colonial Library.—The Colonies and India, 1883.

SMITH, H.—Rainfall: Results of Twenty-five Year's Observations at Hull.

SNELL, H. S.—An Account of Experiments to test the accuracy of Registering Anemometers.

SOLANDER, E.—Om isförhallandena i Sveriges rinnande vatten.

STOKES, J.—Annual Report of the Devonshire Hospital and Buxton Bath Charity for the year 1882.

SYMONS, G. J., F.R.S.—British Rainfall, 1882.—Note on the Establishment and First Results of Simultaneous Thermometric and Hygrometric Observations at Heights of 4 and 170 feet, and of Siemens' Electrical Thermometer at 260 feet above the ground.—Servizio Meteorico-Agrario, Anno III., Nos. 20 to 28.—Symons's Monthly Meteorological Magazine, 1883.

TARBOTTON, M. O.—Meteorological Observations at Nottingham, 1882.

TAYLOR AND FRANCIS, MESSRS.—Taylor's Calendar of the Meetings of the Scientific Bodies of London for 1883-84.

THE EDITOR.—'Ciel et Terre,' Vol. III. No. 21 to Vol. IV. No. 20.

„ 'Nature,' Nos. 688 to 739.

„ 'Science,' Vol. I. Nos. 1 to 45.

„ 'The Sanitary Engineer,' Vol. IX. No. 1.

„ 'The Science Monthly,' Vol. I. Nos. 1 and 2.

„ 'The Telegraphic Journal and Electrical Review,' Nos. 267 to 318.

TODD, H.—Meteorological Summary of Observations made at the Observatory, Cambridge, during 1882. (MS.)

TRIPE, Dr. J. W.—Meteorological Observations taken at the Hôtel Belvedere, Davos Platz, Aug. 15, 1882, to March 31, 1883.—Report on the Sanitary Condition of the Hackney District for the year 1882.

TYRER, R.—The Meteorology of Cheltenham during 1882.

WATERS, A. W.—Observations made in St. Moritz, in the Winter 1882-3.

WHIPPLE, G. M.—Meteorology, or Weather Knowledge: its Progress and Modern Aspects.—The Year-Book of Photography for 1883.

WISE, DR. A. T. T.—Wiesen as a Health Resort in Early Phthisis.

WOEIKOFF, Dr. A.—Résultats des observations sur la vitesse du vent en Russie et période diurne de cet élément (printed in Russian).—Ueber die Grösse der täglichen Warmeschwänkung in ihrer Abhängigkeit von den Localverhältnissen.

WRAGGE, C. L.—The Autumn and close of 1879 in the vicinity of the Staffordshire Moorlands.

APPENDIX VII.

REPORTS OF OBSERVATORIES, &c.

THE METEOROLOGICAL OFFICE.—Lieut.-Gen. R. Strachey, R.E., C.S.I., F.R.S., Chairman of Council; Robert H. Scott, M.A., F.R.S., Secretary; Captain H. Toynbee, F.R.A.S., Marine Superintendent; Nav. Lieut. C. W. Baillie, F.R.G.S., Assistant Do.

Marine Meteorology.—The investigation into the meteorology of the North Atlantic for the period from August 1st, 1882, to August 31st, 1883, has been the work of the Marine Department during the year. The office has been able to collect a very copious amount of information, thanks to the ready cooperation of shipowners and captains, who have either supplied forms filled up, or afforded facilities for the extraction of data from their logs. Up to date 10,502 forms have been received for the thirteen months, which gives an average of 808 forms for each month; 2,563 ships have co-operated in sending in these forms. The charting of this immense mass of observations is progressing steadily and satisfactorily.

The Charts of the Surface Temperature of the three oceans have been engraved, and the work will now appear at once.

The inquiry into the distribution of barometrical pressure over all the oceans has made good progress. The charts for the month of August have been completed, and others are in an advanced state. To give some idea of the amount of work which this inquiry entails, it may be stated that for the Atlantic alone, for the month of August, the chart contains the results of the discussion of 79,000 observations.

It may be of interest to the Fellows to learn that the office has compiled an Index showing the amount of data existing in its possession for every two-degree square over the entire ocean.

The *Barometer Manual* (Ed. 1871) having been long out of print, the Council has been requested by the Board of Trade to prepare a new edition of this little work suitable for the use of candidates at examinations in the Merchant Service. The Manual is now completed, and will appear about Easter under the title of *The Barometer Manual for Seamen.*

Weather Telegraphy.—There is nothing new to be reported in the work of this department.

Land Meteorology of the British Isles.—The engraving of the continuous curves for the seven observatories for the twelve years 1869-80 has been completed, and the Council have announced that these curves will not be reproduced in future. The arrears of the *Quarterly Weather Report* are now in process of being cleared off. The volume of engraved curves for 1878 contains an important paper by Gen. Strachey, on the calculation of cumulative temperatures for agricultural purposes, on the principles proposed by Alphonse de Candolle. It is proposed to introduce tables giving these Temperatures in the *Weekly Weather Report* for 1884.

In the Parliamentary Report of the Office for the year 1882-3, it was announced that the Council proposed to discontinue four of their self-recording observatories. Of these, that at Armagh has ceased operations, Stonyhurst and Glasgow are being carried on by the respective authorities at the stations, and as regards Falmouth, the Royal Cornwall Polytechnic Society has undertaken to erect a new observatory in a situation more favourable than that of the present building, and accordingly an observatory at Falmouth will be continued. The Returns from the Stations of the Second Order for 1879 have appeared. The volume for 1880 is in the press. It will contain returns from several Scotch stations, obtained from the Scottish Meteorological Society.—*April 1st*, 1884.

Royal Observatory, Greenwich.—W. H. M. Christie, M.A., F.R.S., Astronomer Royal.—No important change has been made in the Meteorological Department of the Royal Observatory during the past year.

The time-scales of all the photographic registers, both magnetical and meteorological, being now of the same length, excepting those of the dry and wet bulb thermometers, it was desirable that the same length of scale should be introduced also for these instruments. Adaptation of the old apparatus was, however, hardly practicable, and since, in other points, some changes might be usefully made, it was resolved to construct a new apparatus, designed so that whilst still retaining the same character, the register of the wet bulb should be immediately under that of the dry bulb. Messrs. Negretti and Zambra have the new apparatus in hand, and it is hoped that before many months it will be at work.

The use for the photographic records of Morgan and Kidd's "Argentic-gelatine-bromide-paper" is still continued, with great success.

The observations of temperature of the river Thames (brought to a conclusion in the year 1879 in consequence of the police ship at which the observations had been made being moved from the stream on to the river bank) have during the past year been recommenced, the Corporation of London having requested Mr. Symons to organise a Meteorological Station at the Foreign Cattle Market, Deptford, including thermometers for river temperature. The observations of river temperature made by Mr. Philcox, clerk of the market, are reported weekly to Greenwich Observatory, and included in the meteorological return supplied therefrom to the Registrar General. They will be also inserted in the volume of *Greenwich Observations.*—*March 19th*, 1884.

Royal Observatory, Edinburgh.—Professor C. Piazzi Smyth, F.R.S.E., Astronomer-Royal for Scotland.—During the past year the computation of the bi-diurnal meteorological observations of six towns and fifty-five town and

country stations of the Scottish Meteorological Society for the monthly and quarterly returns of the Registrar-General of Births, Deaths, &c., in Scotland, has been performed as usual.

The Rock thermometers are recorded, as heretofore, once a week. The small daily Meteorological Register connected with the Time Signals is steadily kept up; and the Astronomer finds it advisable to keep another small but special Meteorological Register at his private house, wherein Rain-band Spectroscopy is a distinct feature.

He has also communicated to the Royal Society, Edinburgh, a rather long discussion on certain cases of "Bright clouds on a dark night sky," wherein the importance of extra care in wet-bulb hygrometrical observations is brought out very vividly.—*Jan.* 15, 1884.

KEW OBSERVATORY.—G. M. Whipple, B.Sc., F.R.A.S., Superintendent.—The several self-recording instruments for the continuous registration respectively of atmospheric pressure, temperature, and humidity, wind (direction and velocity), sunshine, and rain, have been maintained in regular operation throughout the year. The tabulations of their traces, copies of all the eye observations and weather notes, have been transmitted weekly to the Meteorological Office as usual.

Observations have been made on favourable occasions with the Stewart actinometer on the Observatory lawn, and the results communicated to the Meteorological Council, who defray the cost they entail. Owing to the rarity at Kew of the occurrence of periods of perfectly clear sky sufficient in duration for a satisfactory experiment with Stewart's apparatus, the Committee have instituted inquiries with a view to obtaining other actinometers, constructed on thermo-electrical principles, for comparison with it.

With a view of investigating the causes of the differences in the readings of black bulb thermometers *in vacuo*, the Superintendent obtained on loan from Messrs. Negretti and Zambra six of these intruments constructed according to his suggestions. They were after verification arranged on a stand on the Observatory lawn, beside the Observatory standard of reference, and read daily during the summer months. The observations have been discussed, and the results indicate that the discrepancies observed in the readings of this class of instrument are mainly to be attributed to want of uniformity in the sizes of the thermometer bulbs, and in the amount of lampblack with which they are covered. A paper giving a detailed account of the experiment was read by the Superintendent before the Society at the December Meeting.[1]

At the request of the Meteorological Council, a series of experiments have been commenced with Captain Abney's Photo-Nephograph, described in the Report of the Council for 1881. Two of the cameras, with their tripod stands, have been received at the Observatory, a base line of 180 yards has been marked off on the level path leading across the park from the Observatory, and a carriage for conveying the battery and reels of wire constructed. A code of signals has been arranged to enable the observers at the cameras to work in accordance with each other, and several successful pairs of cloud negatives have been obtained, but no steps have yet been taken towards the permanent installation of the apparatus at the Observatory.

The observations of the maximum and minimum temperature of the surface water of the pond, which were taken for the late Mr. Greaves daily at 9 a.m., were discontinued at his request on May 1st, and the results were forwarded to him.

The experiments on the fall of temperature of the lower layers of the atmosphere at sunset, instituted at the suggestion of Professor Tyndall, were terminated on February 16th.

The number of instruments verified during the past year amounted to about 9000, again showing a considerable increase as compared with the preceding year.

The Committee have recently revised the regulations for the verification of graduated instruments, fixing a linear value equal to 0·01 in. or 0·25 mm. as the limit to which corrections are to be assigned to scales intended to be read by the unassisted eye.

[1] *Quarterly Journal*, Vol. X. p. 45.

From time to time comparisons have been made between the two Welsh Standard Barometers and Newman No. 34, the working Standard of the Observatory, and their relative values have been found to remain unchanged. Mr. F. Waldo, of the United States Signal Department, being instructed by Major-General W. B. Hazen, Chief Signal Officer, to compare the Standard Barometers of their Department with the European Standards, visited the Observatory in July, and made a lengthened comparison of two Standards by Fuess, which he brought with him, with the Observatory Working Standard, Newman No. 34. The results of his comparison have not yet been communicated to the Committee, but Dr. Chistoni, of the Italian Meteorological Service, has published in the *Annale della Meteorologia* an account of the results of his comparisons of Kew and other Standard Barometers, which indicates a very close agreement between them.[1]—*January* 1884.

RADCLIFFE OBSERVATORY, OXFORD.—E. J. Stone, M.A., F.R.S. Radcliffe Observer.—The meteorological observations have been regularly made on the same plan as last year. The self-recording instruments have been in satisfactory operation, and the photographic curves are very good. Frequent readings of the standard instruments are taken by the assistant on astronomical duty during the night for check of the photographic curves.

On July 16th the small anemometer, which had become worn, was replaced by a new one by Negretti and Zambra.

The rain-gauges have been periodically tested, and are in good order.

The meteorological results for 1881 are rapidly passing through the press, and those for 1882 are under discussion.

Eye-readings taken during 1883 are reduced, and six months' curves from the self-recording instruments are (excepting the barograms) tabulated.

Atmospheric Pressure, Temperature, and Rainfall, have during the past year been slightly above the average.

Weather reports have been supplied daily (by telegram) to the Meteorological Office; bi-monthly to the United States Signal Office; monthly to the Registrar General, *Midland Naturalist*, and the local newspapers; yearly for insertion in *Symons's British Rainfall*; and to many meteorologists by request.

The atmospheric disturbance caused by the recent eruption at Java is distinctly shown on the barometric curve.—*Jan.* 1884.

CAMBRIDGE OBSERVATORY.—Professor J. C. Adams, M.A., F.R.S.—The meteorological work at this Observatory has been carried on as in former years. The observations are made at 8 a.m., 2, and 6 p m., and telegrams are sent every morning to the Meteorological Office.

No change has been made in the instruments.

A half-yearly Summary has been drawn up, and published in the *Cambridge Chronicle*.

On three days during the year over 1 inch of rain was measured: June 21st, 1·185 in.; June 25th, 1·271 in.; and September 29th, 1·210 in. The mean reading of the barometer for the year was 29·949 ins. The mean yearly reading for dry bulb thermometer 48°·8, wet bulb 46°·5, maximum 57°·0, and the minimum 40°·7. The highest temperature for the year was 82°·0 on June 30th; and the lowest, 16°·5, on March 9th. The amount of rainfall for the year was 26·231 ins.; and the number of rainy days 175 The average rainfall from last twenty years was 23·767 ins.; and number of rainy days, 173. The total number of hours of bright sunshine was 1,546.—*Jan. 16th*, 1884.

STONYHURST COLLEGE OBSERVATORY.—Rev. S. J. Perry, M.A., F.R.S.—During the past year, a considerable time has been devoted to the extra meteoro-

[1] An abstract of this paper was printed in the *Quarterly Journal*, Vol. IX. p. 65.

logical and magnetic work undertaken for Dr. Wild of St. Petersburg in connection with the International Polar Commission of 1882-83. No change has been made in the routine duties of the past years, the photographic registration of the principal data of the meteorological and magnetic instruments being always continued, along with as many daily drawings of the solar surface and measures of the chromosphere and spot spectra as the weather will permit.

A large number of first-class instruments for meteorology, magnetism, and astronomy have been procured for the Rev. F. Vines, director of the Havana Observatory, and all are now in use at that important station of the West Indies.

A meteorological observatory has also been started at St. Ignatius' College, Malta, the director being the Rev. J. Scoles, S J. A complete set of meteorological instruments was sent out at the beginning of the year to this new observatory, and they have been in constant use since the beginning of May. The results obtained will be printed as a supplement to the Annual Report of the Stonyhurst Observatory. The usual reports and results have been forwarded during the year to the Meteorological Office, to the Registrar-General, to the French Meteorological Society, to the Upsala Observatory, to the Signal Service Office, U.S., and to such journals and individuals as have applied for information. The reduction of our solar observations is now occupying our chief attention.—*Jan. 22nd*, 1884.

The Great Storm of January 26th, 1884. By William Marriott, F.R.Met.Soc., Assistant Secretary.

[Read February 20th, 1884.]

The Storm which was experienced in these Islands on January 26th, 1884, was so remarkable for its violence and large area, as well as for the unprecedentedly low reading of the barometer at its centre, that a brief account of its history may perhaps not be uninteresting to the Fellows of the Royal Meteorological Society.

It is almost beyond doubt that the fortnight comprised between January 19th and February 1st has been the most stormy period on record of late years in the North of Scotland.

On January 19th a very remarkable storm passed over the North of Scotland, and the Orkneys and Shetlands. At 2 p.m. the barometer reading at Stornoway was 30·27 in. and at 6 p.m. it was 30·17 ins., but at 10 p.m. the mercury had fallen to 29·21 ins., *i.e.* a fall of 0·96 in. had occurred in four hours, being at the average rate of 0·24 in. per hour. This is probably the most rapid fall of the barometer ever recorded in the British Islands. At Sandwick in the Orkneys, the anemometer on the morning of the 20th recorded a wind movement of 100 miles from 7.50 to 8.55 a.m., being at the rate of 92·3 miles an hour. This is the highest velocity continued over so long a period of time known to have occurred in this country.

This storm was followed by another on the 20th, and by a third on the 21st; both of them pursued nearly the same course.

On the 23rd a depression passed across the south of Scotland from West to East, and caused considerable loss of life and property. Another depression passed to the north of Scotland on the night of the 24th, and

moved away to the eastward on the 25th. These depressions were followed on the 26th by the one which forms the subject of this paper.

Isobaric charts have been prepared for each hour from 9 a.m. on the 26th to 8 a.m. on the 27th; and by this means the special features of the storm have been ascertained, and its course tracked across the country. Figs. 1 to 5 give the charts for every three hours from noon to midnight. From these charts it will be seen that the centre of the depression reached the north-west coast of Ireland about noon, and moved in a north-easterly direction across the north of Ireland and the middle of Scotland, reaching Aberdeen by about midnight. Its rate of progress was therefore about thirty miles an hour.

The pressure at the centre of the depression was exceedingly low, the readings of the barometer being below 28·0 ins. all over Scotland from 6 to 11 p.m. The lowest reading (yet reported) was 27·332 ins. at Ochtertyre near Crieff at 9.45 p.m.

On referring to the charts it will be seen that the region of lowest pressure embraces a large area, and that the isobars over the middle and north of Scotland are wide apart. This is borne out by the anemometer records, the velocity falling to fifteen miles an hour at Aberdeen at midnight, and to nine miles an hour at Sandwick, in the Orkneys, at 1 a.m. on the 27th.

Thunderstorms occurred on the south-eastern side of the depression, and travelled in an easterly direction at the rate of about thirty miles an hour across the south of Ireland and the greater part of England to the east coast. These thunderstorms were most probably associated with a subsidiary depression, which was no doubt the cause of the bulging out of the isobars over the south of England.

Another peculiarity was a very sudden rise in the reading of the barometer over the southern part of England directly after the minimum had occurred. The changes at several of the stations were as follows:—

			In.
Babbacombe	5.18 to 5.22 p.m.	rise of	·08
Hodsock	6.10 to 6.15 p.m.	„	·05
Isleworth	7.24 to 7.31 p.m.	„	·05
Camden Square, London	7.38 to 7.41 p.m.	„	·06
Greenwich	7.35 to 7.55 p.m.	„	·09
Geldeston	8.45 to 8.52 p.m.	„	·05

The *Scotsman* of January 31st contains an interesting account, furnished by Mr. Omond, of the Storm on the summit of Ben Nevis, 4,406 ft. above the sea. The following are the barometer readings for the 26th (corrected for temperature only):—

	Ins.		Ins.		Ins.
Noon	24·032	5 p.m.	23·413	9 p.m.	23·195
1 p.m.	23·824	6 „	23·354	10 „	23·228
2 „	23·648	7 „	23·244	11 „	23·282
3 „	23·541	8 „	23·179	Midnight	23·330
4 „	23·448	8.30 „	23·173		

Fig. 1.

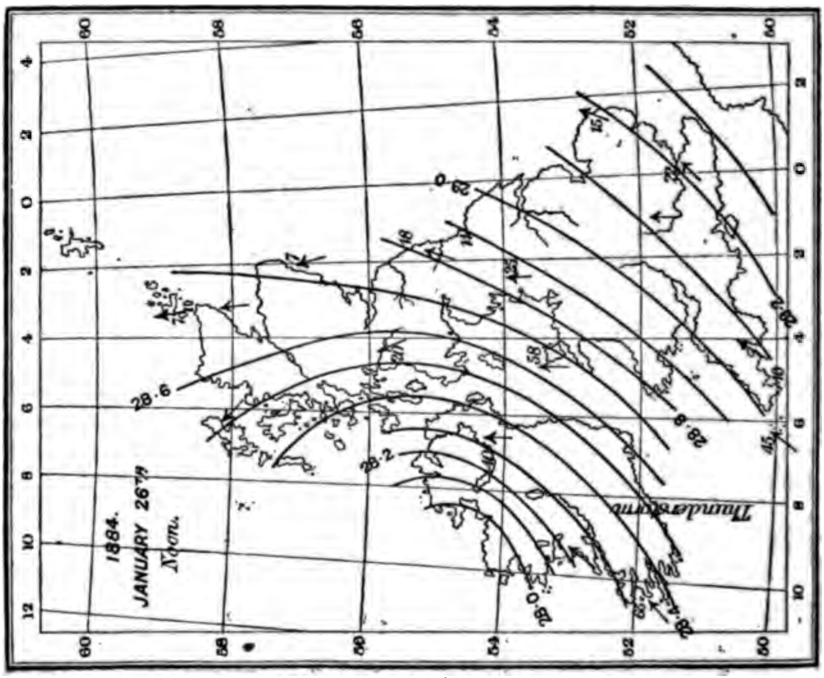

1884.
JANUARY 26TH
Noon.
Thunderstorms

Fig. 2.

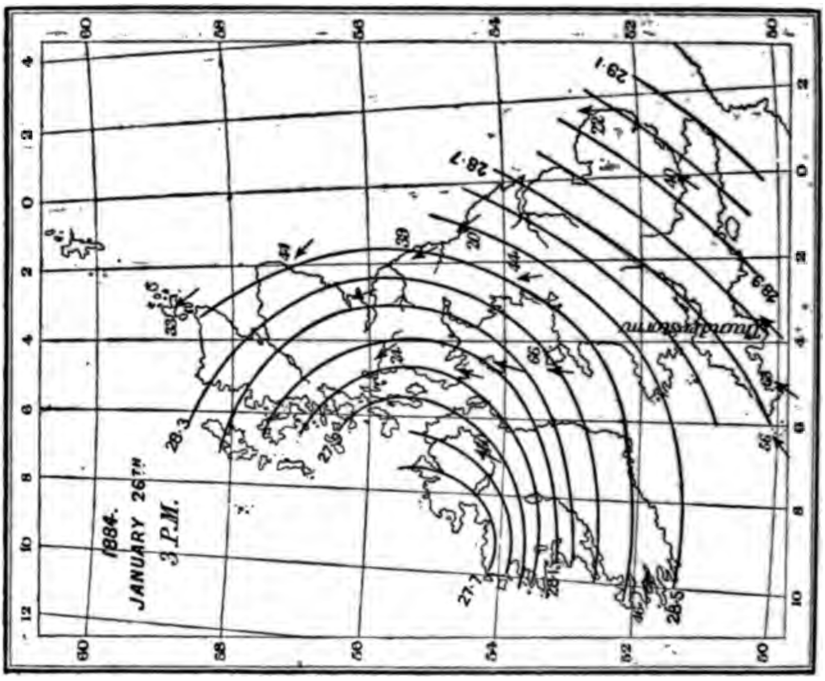

1884.
JANUARY 26TH
3 P.M.
Thunderstorms

FIG. 4.

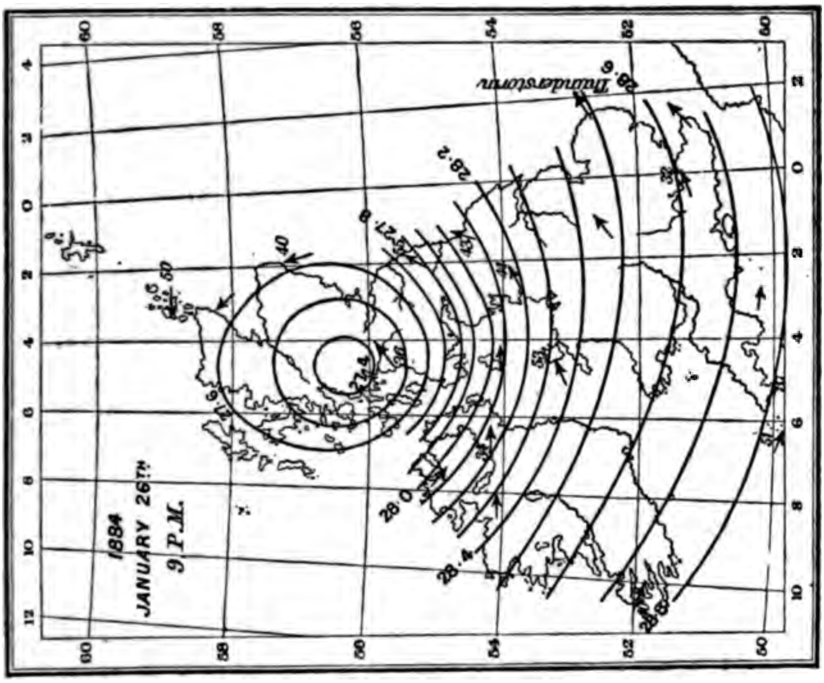

1884
JANUARY 26TH
9 P.M.
Thunderstorm

FIG. 3.

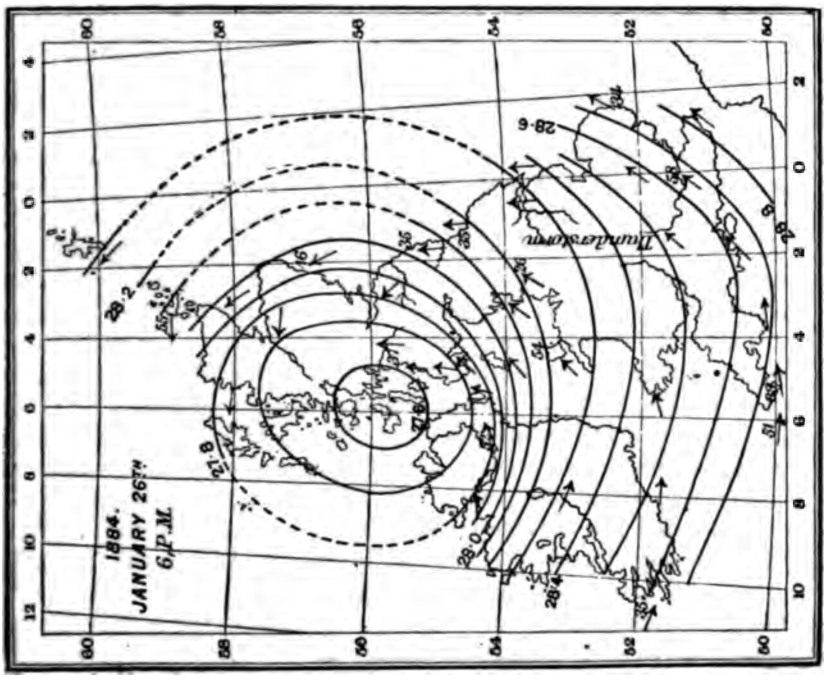
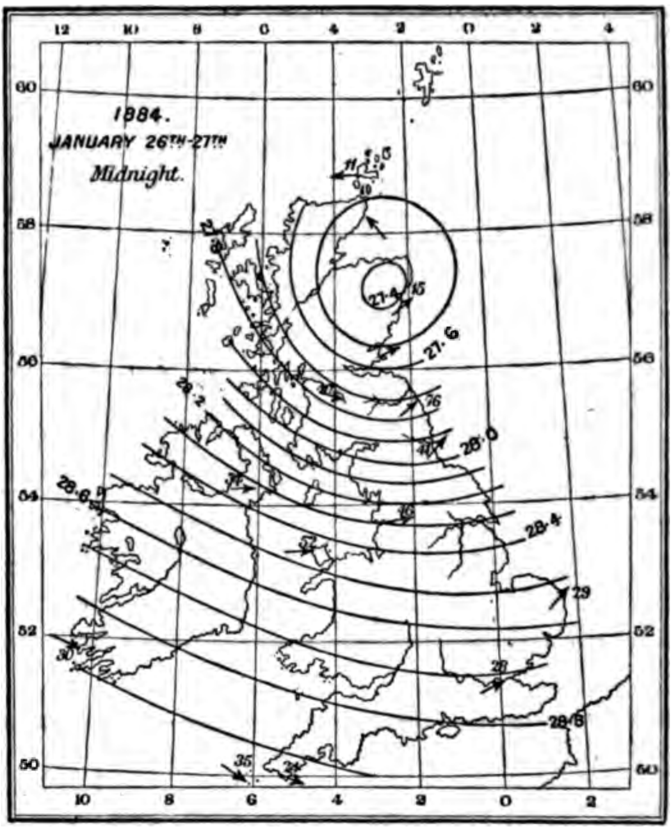

1884.
JANUARY 26TH
6 P.M.
Thunderstorm

FIG. 5.



The lowest reading, 28·178 ins., occurred at 8·30 p.m., while about the same time the lowest reading at Fort William (the low level station), reduced to sea level, was 27·467 ins. or 4·294 ins. higher than at the top of the Ben.

At noon the temperature on the summit of the mountain was 15°; but from that time until 10 p.m., no observations could be taken on account of the fury of the gale. At 10 p.m. the temperature was 22°. The direction of the wind at noon was South-east, force 10; at 7 p.m. it was still blowing from the South-east, force 8; but at 10 p.m., after a brief calm, it shifted to East-north-east, force 4. During all this time snow and fog with heavy drift were prevalent. While the barometer was falling most rapidly, Mr. Omond took observations every quarter of an hour, though with considerable difficulty on account of the "pumping" of the mercury, the violence of the gale as it passed over the observatory causing a constant pulsation of the air inside the room. The pumping amounted to about 0·1 in. Had the mercury gone down 0·2 in. lower it would have been beyond the scale of the instrument, although this was specially constructed for the station. The reading of the barometer on October 16th, 1883, the day the observatory was opened, was *28·944 ins.* This gives an observed range of 5·771 ins. at that level.

In connection with the thermometer readings, it may be mentioned that at 1 p.m. Mr. Omond made an attempt to get at the screen. Tying a rope round his waist, the end of which was held by an assistant within the porch, Mr. Omond crept cautiously out from the shelter of the observatory; but so great was the violence of the gale that he could make no headway against it, and was glad to return. At 7 p.m. another attempt was made. The observers got as far as the screen, but found it impossible to read the thermometers owing to the blinding drift lashing in their faces. At 10 p.m. it was calm enough for Mr. Omond to go out alone, and the reading of 22°, recorded above, was obtained.

Table I. gives the hourly readings of the barometer, reduced to sea-level, at ten stations in various parts of the country. These readings are all from mercurial barometers. A very large number of barometer readings have been received from all parts of the British Islands, and have been utilised in the preparation of the charts, but as these are not continuous, they have not been included in the Table.

TABLE I.

HOURLY READINGS OF THE BAROMETER (REDUCED TO SEA-LEVEL) FROM 9 A.M. JANUARY 26TH TO 9 A.M. JANUARY 27TH.

Hour.	Valencia.	Falmouth.	Kew.	Greenwich.	Geldeston.	Stonyhurst.	Penrith.	Glasgow.	Aberdeen.	Dun Echt.
	Ins.	Ins.	Ins.	Ins.	Ins.	Ins.	Ins.	Ins.	Ins.	Ins.
26th. 9 a.m.	28·67	29·26	29·32	29·30	29·18	29·08	28·99	28·88	28·87	..
10 „	·52	·22	·30	·29	·20	29·02	·94	·82	·85	..
11 „	·39	·15	·26	·25	·24	28·97	·87	·74	·80	..
Noon	·34	29·05	·18	·19	·21	·84	·76	·61	·75	28·69
1 p.m.	·40	28·95	·11	·12	·15	·73	·64	·45	·66	..
2 „	·39	·85	29·03	29·04	29·07	·60	·48	·25	·55	..
3 „	·43	·73	28·95	28·96	28·99	·45	·31	28·08	·40	..
4 „	·49	·63	·86	·88	·90	·30	·15	(27·90)	·22	..
5 „	·55	·65	·75	·78	·79	·27	·11	(·82)	28·05	..
6 „	·59	·71	·65	·67	·70	·25	·06	·70	27·92	..
7 „	·64	·73	·54	·57	·57	·23	28·02	·55	·82	..
8 „	·69	·77	·60	·60	·48	·21	27·97	·45	·72	27·67
9 „	·74	·79	·61	·60	·50	·23	·93	·43	·61	·55
10 „	·77	·83	·64	·62	·49	·24	·89	·51	·51	·45
11 „	·82	·86	·68	·66	·53	·25	·93	·62	..	·40
27th. Midnt.	·88	·92	·71	·70	·55	·30	27·98	·70	..	·40
1 a.m.	·93	28·97	·74	·74	·59	·35	28·07	(·83)	..	·46
2 „	·95	29·01	·78	·78	·63	·41	·14	27·93	..	·51
3 „	28·99	·06	·82	·81	·65	·47	·22	28·04	..	·55
4 „	29·03	·09	·87	·86	·68	·52	·29	·10	..	·58
5 „	·04	·10	·92	·92	·73	·57	·34	·19	..	·67
6 „	·09	·17	28·96	·95	·79	·64	·36	·27	..	·74
7 „	·10	·21	29·00	28·99	·84	·68	·51	·34	·81	·80
8 „	·12	·24	·05	29·04	·89	·75	·54	·40	·85	..
9 „	29·13	29·23	29·08	29·08	28·93	28·78	28·59	28·44	27·91	27·98

A violent gale was experienced all over the British Islands, but it was most severe in the north of England and Ireland, and the south of Scotland, where

the isobars were closest together. The greatest tabulated hourly velocities of the wind at each station were:—

26th	11 a.m.	68 miles at	Valencia	26th	5 to 7 p.m.	58 miles at	Greenwich
„	2 p.m.	70 „	Holyhead	„	6 p.m.	55 „	Sandwick
„	3 p.m.	63 „	Falmouth	„	7 p.m.	53 „	Kew
„	3&4 p.m.	56 „	Scilly	„	7 p.m.	47 „	Yarmouth
„	4 p.m.	53 „	Stonyhurst	„	10 p.m.	48 „	Seaham
„	5 p.m.	69 „	Armagh	„	Midt.	76 „	Alnwick
„	5 p.m.	59 „	Aberdeen	27th	7 a.m.	50 „	Glasgow

Table II. gives the velocity of the wind for each hour from 9 a.m. on the 26th to 9 a.m. on the 27th at fifteen stations. The velocities are given in figures on charts 1 to 5.

TABLE II.

VELOCITY OF THE WIND FOR EACH HOUR FROM 9 A.M. JANUARY 26TH TO 9 A.M. JANUARY 27TH.

Hour.		Valencia.	Armagh.	Scilly.	Falmouth.	Holyhead.	Stonyhurst.	Kew.	Greenwich.	Croydon.	Yarmouth.	Seaham.	Alnwick.	Glasgow.	Aberdeen.	Sandwick.
26th.	9 a.m.	63	28	34	30	39	7	12	19	14	23	13	14	5	8	13
	10 „	62	26	33	41	46	16	20	17	16	18	13	15	15	9	13
	11 „	68	36	40	44	58	21	13	18	11	16	22	18	16	9	11
	Noon	65	40	45	49	58	25	13	22	17	15	14	18	20	10	7
	1 p.m.	55	50	50	60	56	42	28	17	19	18	13	22	30	13	14
	2 „	55	48	54	57	70	42	25	29	23	24	17	35	28	29	25
	3 „	46	50	56	63	66	44	42	40	30	22	20	39	24	41	33
	4 „	44	61	56	62	53	53	44	49	34	24	24	42	30	52	38
	5 „	35	69	50	42	59	45	48	58	34	32	30	42	28	59	49
	6 „	35	52	51	39	54	26	52	58	38	34	35	35	37	46	55
	7 „	40	47	51	35	51	33	53	58	40	47	27	24	37	41	54
	8 „	40	38	49	33	52	37	34	42	26	46	36	30	31	38	53
	9 „	40	34	51	37	53	44	20	32	17	30	43	55	36	40	50
	10 „	34	36	53	35	54	43	28	34	22	22	48	69	36	37	25
	11 „	36	37	54	28	53	44	26	39	25	27	47	75	28	18	18
27th.	Midnight	30	34	35	24	52	46	24	28	20	29	44	76	40	15	11
	1 a.m.	27	36	36	22	53	42	22	31	17	28	43	71	42	19	9
	2 „	23	29	42	25	52	50	24	26	18	29	47	63	47	24	10
	3 „	33	31	43	23	43	49	23	32	18	31	42	58	46	23	13
	4 „	35	24	49	26	49	46	18	27	18	33	45	59	48	27	12
	5 „	39	19	49	30	50	37	19	24	17	33	41	57	49	37	20
	6 „	39	17	49	29	45	54	17	25	16	28	38	63	48	42	23
	7 „	40	18	49	28	45	42	18	29	17	30	34	56	50	44	23
	8 „	35	18	51	31	42	42	22	25	17	32	33	43	41	50	13
	9 „	36	17	47	34	36	35	23	28	20	29	33	46	40	54	17

I have confined my remarks to the storm as it was experienced in the British Islands, but the depression was of very large area, the gale extending to the south of France and Switzerland.

From an examination of past records it appears that we have no previous evidence of so low a barometer reading in these Islands as 27·332 ins. The lowest readings on record apparently are

		Ins.
1821, December 25th	... ...	28·016 at Greenwich
1839, January 7th	... ...	27·695 at Aberdeen
1852, December 27th	... ...	27·984 at Culloden
1865, December 31st	... ...	27·68 at the Hoy Lowlight, Orkney

On February 5th, 1870, the reading of 27·38 ins. was recorded on the Cunard Steamer *Tarifa* in the Atlantic, in lat. 51° N. and long. 24° W.

The storm of January 26th, 1884, may therefore be considered as one of the most remarkable which have occurred in the British Islands.

Table III. gives the lowest reading of the barometer at Greenwich in each year for the seventy four years, 1811 to 1884. Those from 1811 to 1840 are from the MS. Journals of the late Mr. Henry Belville, which are now in the possession of the Society; and those from 1841 to 1884, at the Royal Observatory, are from the *Greenwich Observations*.

TABLE III.

Lowest Reading of the Barometer at Greenwich during the Seventy-Four Years, 18 1–1 84 (reduced to Sea-Level).

Year.	Date.	Time.	Reading.	Year.	Date.	Time.	Reading.
			Ins.				Ins.
1811	Oct. 26	Noon	28·711	1850	Nov. 20	Noon	28·762
1812	Oct. 19	6.0 p.m.	28·542	1851	Mar. 23	10.30 a.m.	29·009
1813	Oct. 17	8.0 a.m.	28·687	1852	Oct. 27	9. 0 a.m.	28·913
1814	Jan. 29	5.0 p.m.	28·233	1853	Oct. 19	3. 0 p.m.	29·001
1815	April 22	Noon	28·859	1854	Jan. 7	9. 0 p.m.	28·979
1816	Dec. 12	Evening	28·748	1855	Mar. 22	Noon	28·926
1817	Dec. 8	..	28·532	1856	Sept. 28	10.50 a.m.	28·858
1818	Mar. 4	Night	28·530	1857	Oct. 8	3. 0 p.m.	28·839
1819	Feb. 21	Noon	29·156	1858	Nov. 27	3. 0 p.m.	29·014
1820	Oct. 22	..	28·699	1859	Dec. 26	6.38 a.m.	28·660
1821	Dec. 25	5.0 a.m.	28·016	1860	Jan. 24	1.50 p.m.	28·725
1822	Dec. 2	..	29·033	1861	Nov. 13	9.30 p.m.	28·960
1823	Feb. 2	..	28·613	1862	Oct. 19	9. 0 p.m.	29·128
1824	Nov. 23	..	28·484	1863	Nov. 2	9. 0 a.m.	28·938
1825	Nov. 10	Noon	28·755	1864	Nov. 14	2.20 p.m.	28·776
1826	Nov. 13	10.0 p.m.	28·806	1865	Jan. 14	11.55 a.m.	28·560
1827	Mar. 4	Noon	28·800	1866	Feb. 11	4.34 p.m.	28·620
1828	Feb. 22	Morning	28·954	1867	Jan. 8	7.21 a.m.	28·705
1829	April 14	10.0 p.m.	28·964	1868	Dec. 24	2.10 p.m.	28·690
1830	Jan. 20	8.0 a.m.	28·736	1869	Sept. 12	5.30 a.m.	28·750
1831	Dec. 7	Noon	28·980	1870	Oct. 24	7. 0 a.m.	28·895
1832	Aug. 28	2.0 p.m.	29·152	1871	Jan. 16	7.20 a.m.	28·879
1833	Nov. 28	7.0 p.m.	28·755	1872	Jan. 24	5.20 a.m.	28·380
1834	Jan. 12	3.0 p.m.	29·111	1873	Jan. 19	10.30 p.m.	28·453
1835	Oct. 10	Morning	28·747	1874	Dec. 9	4. 0 a.m.	28·613
1836	Feb. 2	8.0 p.m.	28·691	1875	Nov. 11	2.40 a.m.	28·619
1837	Nov. 1	4.0 p.m.	28·799	1876	Dec. 4	11. 0 a.m.	28·407
1838	Nov. 28	10.0 p.m.	28·653	1877	Nov. 12	0.10 a.m.	28·717
1839	Jan. 30	10.0 p.m.	29·015	1878	Oct. 26	9.40 a.m.	29·022
1840	Feb. 4	Noon	28·627	1879	Feb. 10	7. 0 p.m.	28·842
1841	Oct. 6	10.57 a.m.	28·867	1880	Nov. 18	11.30 p.m.	28·736
1842	Oct. 23	10.40 a.m.	28·851	1881	Dec. 18	4.50 a.m.	28·745
1843	Jan. 13	0.53 p.m.	28·266	1882	Oct. 24	Noon	28·781
1844	Feb. 26	2. 0 p.m.	28·695	1883	Sept. 2	4. 0 p.m.	28·787
1845	Dec. 20	6. 0 a.m.	28·829	1884	Jan. 26	7.35 p.m.	28·520
1846	Dec. 23	8. 0 a.m.	28·706				
1847	Dec. 7	2.30 a.m.	28·550				
1848	Feb. 26	9.45 a.m.	28·469				
1849	Jan. 10	Noon	28·999				

There are now several self-recording barometers at work in various parts of the country, viz. 1. Photographic, in use at most of the observatories; 2. King's, in use at Bidston and Dun Echt; 3. Redier's, in use at Camden Square and Geldeston; 4. Recording aneroids with a pencil dot at each hour (a sluggish form of instrument, which does not show the sudden fluctuations between the hours); and 5. Richard's aneroid with continuous trace (this appears to work fairly satisfactorily). Owing, however, to the atmospheric pressure falling to so low a point, the records of some of these barographs were lost, as the traces went beyond the range of the instrument. In order to guard against a similar loss in future it is desirable to recommend that all barometers and barographs be so constructed that their scales shall embrace sea-level pressures of 27·0 ins. to 31·2 ins.

In conclusion I have to express my thanks to the President (Mr. Scott) for allowing me to examine and use all the material in the Meteorological Office bearing on the storm; also to Mr. Symons for handing over to me all the data received by him; and to the observers who have supplied me with copies of their readings.

DISCUSSION.

CAPTAIN TOYNBEE remarked that he was much interested in the fact that on each diagram a thunderstorm was shown in a South-easterly direction from the centre of the storm. This was strong evidence that the thunderstorm travelled to the north-eastward with the storm. He also called attention to the fact that it existed in the part of the storm where the wind changed from South-west to West and North-west; and that there is generally heavy rain or hail in this position. So notorious is this amongst seamen that they make a rule to prepare for a change of wind when the heavy rain sets in during a South-westerly gale in the Northern hemisphere, which rain generally occurs at the time of lowest barometer. He thought it likely that this South-easterly bearing was the line of meeting between the cold and relatively dry North-west wind (which is probably a downward as well as a horizontal rush of air into the rear of the area of low pressure) and the warm moist South or South-west wind which flows towards the eastern side of the same area of low pressure; the rain or hail being condensed moisture caused by the meeting of the warm and cold currents of air. As the area of low pressure passes to the North-eastward, the weather clears, and the cold Westerly or North-westerly wind prevails.

Mr. ABERCROMBY said that it was a common occurrence during the passage of a squall or shower, for the barometer to jump as much as ·01 in., and he believed that the rapid rise in the case of this cyclone was due to the thunderstorm which occurred just as the barometer turned upwards, at the trough of the cyclone. A rise of the barometer due to this cause should not be confounded with a rise caused by the passage of the rear of a cyclone, as the two were entirely different phenomena. For the same reason the rate of squall rise cannot fairly be compared with the rate of pure cyclone rise.

Prof. ARCHIBALD said that the occurrence of a calm centre in the present case was a point of considerable interest, as the cyclones of these regions did not often exhibit them like those of the tropics. This he thought was possibly due to the fact that they were here subsidiaries of the large polar cyclone with its centre near Iceland, and consequently the air in their centres had a proper motion of its own round this centre. He thought it would be desirable to obtain other mountain observations besides those on Ben Nevis, as, according to Ferrel's theory, the formation of cyclones mainly depends on the distribution of the horizontal and vertical temperature gradients. The thunderstorm might arise without any descending current, such as that supposed by Captain Toynbee; but simply by the overlapping of the warm and moist South-west under-current by

the cold and dry North-west upper current; the sudden bursting through the latter by the former producing by rapid condensation a rise of electric potential (in the manner indicated by Lord Rayleigh).

Mr. C. HARDING considered that the most interesting features of this storm were its very low barometer readings, and its large area. The low reading on board the S.S. *Tarifa* on February 5th, 1870, had been referred to by Mr. Marriott. It was recorded in about the same latitude as London, but 500 miles to the west of our Islands; and the reading 27·33 ins., which was by a standard barometer, had been fully examined, and was believed to be correct. The semi-diameter of the storm of January 26th was about 850 miles; but although this showed that it was of considerable extent, it was not so large as some which occur in the Atlantic; as he had known a gale to be blowing at the same instant of time on the west coast of Ireland, and at Newfoundland. He had looked for traces of the storm of Jan. 26th in the Atlantic, but without much success; the earliest record he could find of it being on the morning of January 26th. He had, however, seen a telegram from the United States in *Lloyd's List* that day (February 20th), which stated that the S.S. *Somerset* on January 25th, in lat. 50° N. long. 36° W., encountered a terrific gale from West-south-west, which lasted twelve hours. The U.S. War Department Weather Map shows an area of low barometer readings over Lake Michigan at 11 p.m., 22nd; this disturbance travelled eastward over America on the 23rd, and if it was the same as that met by the *Somerset* on the 25th, it gives rather more than thirty-five miles an hour for the rate of travel from the 22nd to the 27th. This agrees well with the rate at which the storm came over our Islands, but more data would be needed before the storm could be tracked with any approach to certainty.

Mr. WHIPPLE said with respect to the sudden oscillations in the curves of the barometer, that he some time ago read a paper before the Society[1] on this subject, and so far as he remembered, the rise was simultaneous with a sudden change of wind, generally from South-west to North-west; a great change in temperature took place sometimes, amounting to as much as 15°; and also a large precipitation of moisture either under the form of heavy rain or hail. He had also timed their occurrence as recorded by the different observatories of the Meteorological Council, and by this means had tracked their path across the country, and had found that it was generally from South-west to North-east; the usual rate of travel being from thirty to fifty miles an hour.

THE PRESIDENT (Mr. Scott) remarked that comparatively calm centres did occur not uncommonly in British storms, but they were of large extent. This was especially the case in the storm of November 20th-21st, 1869, when a fall in the barometer of 1·0 in. occurred over an area of 200,000 square miles, and over the North Sea and British Islands the isobars only ranged from 28·5 ins. to 29·0 ins., so that the calm centre was of extraordinarily large extent. In consequence there was hardly any wind over the British Islands, but off the west coast of Ireland a terrific North-west gale was blowing, and one of the best observers for the Meteorological Office, Capt. Fry, of the *Foam*, was blown from off the coast of Ireland to that of Portugal.

THE HEIGHT OF THE NEUTRAL PLANE OF PRESSURE AND DEPTH OF MONSOON CURRENTS IN INDIA. By Prof. E. DOUGLAS ARCHIBALD, M.A., F.R.Met.Soc.

[Read February 20th, 1884.]

IN his *Meteorological Researches*, Part I., 1877, Mr. Ferrel has given a table representing the mean Easterly component of the velocity of the wind for every 5th degree of latitude in the Northern and Southern hemispheres. The values in this table are deduced from his equations for the general

[1] *Quarterly Journal*, Vol. VI. p. 136.

motions of the atmosphere, by the help of Buchan's collection of monthly mean temperature observations for the whole world, corrected by more recent observations. The form in which the velocity is expressed, renders it possible, where the direction of the wind at a high level becomes reversed, to determine approximately the mean level of the plane of neutral pressure (that is, where there is no barometric gradient), since this must necessarily coincide with the stratum of no motion between a lower current and an upper one in precisely the opposite direction.

The equation which gives the eastward velocity is—

$$\frac{dv}{dt} = \frac{\frac{1}{a_1}\frac{d \log P_1}{du} - gh\frac{d a_1}{du}\frac{1}{a_1} + \frac{d^2 u}{dt^2}}{2\,n\cos\theta}\cos^2 i$$

Where $\frac{dv}{dt}$ represents the eastward velocity in kilometres per hour.

a_1 the atmospheric density co-efficient depending on temperature and humidity jointly.

P_1 the pressure at the earth's surface.

h the elevation in kilometres.

u the linear distance south.

v „ east.

n the angular velocity of terrestrial rotation.

i the angle of inclination of the actual path to the eastward motion.

and θ the co-latitude.

In calculating the Eastward component of velocity from this equation, Ferrel neglects the effects of friction and so puts $\cos^2 i = 1$.

The velocities within the tropical zone thus found by integrating the above equation appear in the form $- v + mh$, where M is a factor altering with latitude and season, and the sign — before v means that the velocity at the surface is Westwards. Putting this expression $= o$, we have $h = \frac{v}{m}$ for the height at which the velocity vanishes in an East or West direction.

Ferrel has already noticed the approximate agreement of the heights deduced by this method, when the temperature means for all longitudes are used for every 5th degree of latitude, with those determined by observation for the altitude of the plane of separation between the Trade and Anti-trade winds on the Peak of Teneriffe and elsewhere; and it is obvious, that for the mean of all longitudes, it should within the limits of the errors of observation, and the defects in the method, afford an approximately correct value for the height of the plane of neutral pressure between the equator and the poles. Since, however, owing to the irregular distribution of land and water, and the disturbances they introduce, the temperature gradients, and therefore the atmospheric motions, in regions such as India, differ widely at some seasons from those which would probably occur on a globe composed entirely of either land or water, to compare the results obtained from

Ferrel's equations with those derived from other methods in India, the particular values which they give must be found for this region where local data are procurable. First of all, however, let us examine what happens in the general case where the data from all longitudes are lumped together.

For the following four latitudes, which represent the greater part of India, Ferrel gives the Eastward velocities in the form $-v + mh$, expressed in kilometres per hour as follows:—

TABLE I.

Lat.	At Mean Temperatures, Km. per hour.	January, Km. per hour.	July, Km. per hour.
30° N	− 8·6 + 9·5h.	− 9·1 + 14·7h.	− 8·1 + 4·3h.
25°	−14·4 + 9·4h.	−16·0 + 15·2h.	−12·2 + 3·6h.
20°	−15·1 + 9·0h.	−20·2 + 15·6h.	−11·7 + 2·4h.
15°	−12·5 + 5·6h.	−21·8 + 10·5h.	− 3·8 + 0·6h.

from which are obtained the following values for the height in feet of the neutral plane of pressure, or in this case, the height of the plane of separation of the lower North-east Trade wind from the upper South-west Anti-trade.

TABLE II.

Lat.	At Mean Temperatures.	January.	July.
	Ft.	Ft.	Ft.
30° N	2,958	2,030	6,178
25°	5,347	3,452	11,122
20°	5,479	4,232	15,977
15°	7,316	6,791	20,669
Means	5,275	4,126	13,486

These heights, in accordance both with theory and observation in regions where the normal North-east Trade wind blows more or less at all seasons, are greatest near the Equator, and descend thence until they reach the surface in about lat. 36°. The further fact that the separation or neutral plane is considerably higher in July than in January, might have been supposed *á priori* to be mainly due to the lateral shift of the entire wind system and accompanying pressure gradients with the sun in its seasonal oscillation between the tropics; but apparently from Ferrel's data the point where this plane touches the earth, does not vary enough (only a degree or so, to alone account for the corresponding change in its height. It must, therefore, be concluded that there is besides, a seasonal variation in the vertical height of this plane, depending chiefly on the corresponding changes in the position and velocity of the upper current, which are in turn regulated by the temperature-gradient between the equator and the poles, and are indicated by the different values of the coefficient of h in Table I.

Mr. Blanford, in his *Indian Meteorologist's Vade Mecum* (p. 79), employing a method indicated by Herschel, and explained in a note (p. 98), has determined the height of the plane of neutral pressure between Ceylon and Sikkim; the hill-station observations used being those of Newéra

Elliya (6,150 ft.), and Darjiling (6,912 ft.), and of those on the plains, Colombo and Goalpára. The heights, computed separately for each pair of stations, gave the following results:—

	Sikkim. Feet.	Ceylon. Feet.
November	19,472	19,684
December	9,076	9,228
January	5,905	5,978
February	8,502	8,589
May	11,755	11,965
June	12,128	12,800
July	10,822	10,988
August	9,482	9,570
September	7,465	7,612

It will be noticed that the elevations of the neutral plane in Ceylon only very slightly exceed those in Sikkim, while those derived from Ferrel's equations for the mean of all longitudes differ by many thousands of feet.

The means for January and July, however, are within a measurable distance of each other by both methods, and agree in assigning a greater average elevation to the neutral plane in summer.

In a recent paper published in the *Indian Meteorological Memoirs*, entitled "The Meteorology of the North-west Himalaya," Prof. S. A. Hill, following the same method as that employed by Mr. Blanford, finds the corresponding mean heights of the neutral plane between Ceylon and Dehra Dún in the North-west Himálaya. The Northern stations are Roorkee and Chakráta, and the Southern ones Colombo and Newera Elliya.

The heights are stated below, together with the mean of those given by Blanford between Ceylon and the North-east Himálaya, for comparison.

	Mean of Ceylon and Dehra Ft.	Mean of Ceylon and Sikkim Ft.
November	5,890	19,500
December	5,870	9,100
January	4,480	5,900
February	2,890	8,500
Means	4,407	6,166 [1]
June	14,000	12,200
July	15,780	10,900
August	14,810	9,500
September	12,420	7,500
Means	14,115	10,025

[1] Excluding November, which is abnormal.

Here the means of the respective four months, as well as the values for January and July separately, between Ceylon and Dehra Dún, agree even more closely than those for Ceylon and Sikkim, with the means for latitudes 15°—30° N obtained by Ferrel's method. It must, however, be remembered, that in Ferrel's formula the motion of the air in July is from the East, and represents the Westward component of the Trade wind, which would normally prevail over these latitudes throughout the year. The heights, therefore, so obtained represent the position of the stratum of no motion between the lower North-east Trade Wind and the Upper South-west Anti-trade. The heights of the Neutral Plane, obtained by Blanford and Hill, on the other hand, represent approximately the superior limit of the South-west Monsoon current, and what occurs above this is as yet unknown by observation, though theoretically a compensating current from the North-west might be expected.[1]

It is, therefore, legitimate to compare the values given by Ferrel for the mean of all longitudes with those determined by Blanford and Hill for India in January, when the North-east Monsoon merely represents the normal North-east Trade Wind of the latitude, slightly altered perhaps by the presence of land, and the temperature gradients for different latitudes in India approximate closely to those for the mean of all longitudes, but the values for July cannot be compared, since they represent physical conditions of a totally different character. To allow of a further comparison of Ferrel's and Blanford's methods, I have sought the values which $\frac{dv}{dt}$ approximately assumes in Ferrel's formula when this is treated with data furnished by the stations utilised by Blanford and Hill, with the addition of two intermediate ones. The data are as follows:—

Stations.	Latitudes.		Elevation.	Mean Barometric Pressure (reduced to sea-level for lower and to 7,000 ft. for upper stations.)		Years of Observation.	Mean Temperatures in degrees Fahr. (at sea-level for lower stations).	
				Jan.	July.		Jan.	July.
	°	′	Ft.	Ins.	Ins.		°	°
Chakrata	30	40	7,051	23·305	23·159	4–5	..	..
Roorkee	29	52	887	30·076	29·503	13	58·8	88·1
Darjiling	27	3	6,912	23·329	23·220	8–10	..	..
Goalpara	26	11	386	30·026	29·585	8	64·3	82·4
Bombay	18	54	37	29·988	29·724	5	72·7	80·9
Madras	13	4	22	30·014	29·753	5	76·5	85·7
Newera Elliya	7	0	6,150	23·348	23·312	5–6	..	..
Colombo	6	56	40	29·918	29.870	6–7	79·7	81·2

[1] In the winter the Upper current most probably blows from the South-west, as it then descends to the level of the hill stations, where the prevailing direction of the wind is known by observation to be South-west.

Stations.	Years of Observation.	Mean Wind Direction.		Years of Observation.	Mean Wind Velocity per diem.	
		January.	July.		Jan.	July.
					Miles.	Miles.
Chakrata	..	S 69° W	S 63° W	6–10	114·5	110·1
Roorkee	18	N 71° W	S 37° E	10–13	55·8	78·3
Darjiling	..	S 50° W	S 12° E	10	none	given.
Goalpara	10–11	S 89° E	S 56° E	10	76	91·1
Bombay	5	N 12° W	S 65° W	16–17	243·7	450·3
Madras	5	N 49° E	S 52° W	10	163·7	224·8
Newera Elliya	..	SE	NW	..	61	117·3
Colombo	10–11	NNE	SW to SSW	8–10	160·5	189·6

In working out the values the lower stations have been grouped as below—

	Approximate Mean Latitudes.	Corresponding Mean Temperatures reduced to Centigrade Degrees.	
		January.	July.
Roorkee, Goalpara	28°	15°·5	28°·3
Bombay, Madras	16	23·5	28·3
Colombo	7	26·5	27·0

	Barometric Pressures in Millimetres.		Approximate Gradients per Degree of Latitude.	
	January.	July.		
	mm.	mm.	mm.	mm.
Roorkee, Goalpara	763·0	750·4	—·100	+·425
Bombay, Madras	792·0	755·7	—·150	+·375
Colombo	759·9	758·7	—·190	+·300

And from the formula already quoted, in which

$$a_1 = \frac{1}{g \times 7989^{m} \times (1{\cdot}00154 + {\cdot}004t)}$$

the following values result for $\frac{dv}{dt}$ at the Earth's surface, corresponding to the respective latitudes in kilometres per hour :—

Lat.	January Km. per hour.	July Km. per hour.
28°	– 5·1	+ 23·3
16	– 12·8	+ 32·8
7	– 39·5	+ 62·5

Taking Ferrel's co-efficient for h in the month of January, when the mean

temperature for the latitudes under consideration, differs very little from that derived for the same latitudes on the mean of all longitudes, and adding to the velocities just given the amounts due to the increase of the apparent gradients by the correction of gravity for change of latitude, the following values are found for the velocities at different heights, and the corresponding elevations of the neutral plane in January:—

Latitude.	January Km. per hour.	Neutral Plane Height in ft.
28°	$-\ 7{\cdot}1 + 15\,h$	1,502
16	$-\ 14{\cdot}2 + 13\,h$	3,582
7	$-\ 40{\cdot}0 + 10\,h$	13,120

In the case of latitude 7° the value is evidently affected by the admitted failure of the formula near the Equator, owing to the rapid decrease in the value of $2\,n \cos\theta$.

Omitting this value, those for the other two latitudes are still a good deal lower than those determined by Blanford and Hill's methods, though they approximate to the values given by Ferrel for the mean of all longitudes.

The discrepancy between the results furnished by these two methods, which may be styled the static and dynamic respectively, seem to be partly owing to the failure of Ferrel's formula near the Equator, and partly to the impossibility of properly considering in the formula the effect of friction, varying as it must do with the height.[1]

Thus although the *directions* of the wind at the level of most of the hill-stations agree with Ferrel's theoretical formula, in showing a predominant Westerly component, the *velocities* at the hill-stations, owing to the presence of a land surface, are considerably less than those deduced for the corresponding elevations from the formulæ for India just given. The following approximate comparison for two latitudes may help to illustrate this point:—

Diurnal westerly velocity in miles per hour.

Lat.	Computed at 7,000 feet.	Observed.
28°	864·8	106·4[2]
16°	196·5	45·7

As Ferrel's method is found to be long, complicated, and unsatisfactory, especially when dealing with exceptional cases such as India, I have adopted Blanford's method for the discussion in the remainder of the paper of the

[1] In the formula as it stands, $\cos^2 ij$, which represents the effect of friction, enters equally both into the velocity at the surface and the co-efficient of h. While, therefore, its determination would tend to somewhat reduce the velocity at the surface, it would have no effect upon the elevation of the neutral plane.

[2] The stations employed for these figures are Chakrata and Chikalda (lat. 21°)—the only stations available—and the due westerly component is *calculated* from the observed velocity and resultant direction.

heights of the neutral plane and depths of the monsoon vapour currents during the past decade in India.

Using the data to be found in Blanford's Reports on the Meteorology of India, commenced in 1875, and previous to that date those given in the detached Reports for Bengal and the North-West Provinces, as far as they are stated to be reliable,[1] and adopting the mean values calculated by Blanford and Hill as a basis, I have determined approximately the heights of the neutral plane between Ceylon and Sikkim and Ceylon and Dehra Dun as follows :—

TABLE III.—Height of the Neutral Plane between Ceylon and Sikkim.

	January.				July.			
	G.	g.	P.	H.	G.	g.	P.	H.
	"	"	"	Ft.	"	"	"	Ft.
1870	—·089?	—·080?	..	..	+·201	+·007	23·03	7,298
1871	—·060?	—·088?	..	..	+·262	+·038	22·39	8,315
1872	—·135	—·040	20·55	10,309	+·226	+·025	22·46	8,088
1873	—·146	+·016	23·98	6,231	+·299	+·093	20·35	10,589
1874	—·158	+·004	23·48	7,174	+·197	+·011	23·60	6,540
1875	—·134	+·001	23·38	6,945	+·288	+·081	20·74	10,032
1876	—·198	—·012	22·91	7,498	+·264	+·064	21·20	9,428
1877	—·192	—·088	17·73	13,684	+·310	+·051	21·99	8,542
1878	—·178	—·007	23·06	7,196	+·153	+·012	22·72	7,732
1879	—·191	—·088	17·68	13,749	+·217	—·006	23·39	7,175
1880	[1] ..	..	..	..	+·268	+·058	21·48	9,811
[2]Mean of several years	—·147	+·001	23·33	6,939	+·255	+·072	20·68	10,134

[1] No observations at Newera Elliya.

[2] The means are given by Blandford in the *Vade Mecum*, published in 1877, and the period which they comprise is not mentioned. This will explain the apparent discrepancies between them and the results for single years.

TABLE IV.—Height of the Neutral Plane between Ceylon and Dehra Dun.

	January.				July.			
	G.	g.	P.	H.	G.	g.	P.	H.
				Ft.				Ft.
1871	—·208	—·192	..	..	..	..	..	..
1872	[1] ..	..	..	..	+·280	+·073	21·04	9,917 ?
1873	—·187	+·072	25·58	4,440 ?	[1] ..	..	..	..
1874	—·193	+·138	26·11	3,892 ?	+·264	+·174	10·75	25,913 ?
1875	—·144	+·165	26·89	3,044 ?	+·339	+·057	21·96	8,548 ?
1876	—·151	+·027	24·34	5,796	+·366	+·132	19·63	11,652
1877	—·207	+·008	23·58	6,737	+·388	+·118	20·44	10,805
1878	—·201	+·032	25·09	5,079	+·273	+·131	17·32	15,070
1879	—·190	—·015	22·77	7,625	+·299	+·116	19·18	19,318
1880	[2] ..	..	..	..	+·339	+·191	14·96	12,140
Mean of several years	—·189	+·046	24·60	5,567	+·330	+·153	17·65	14,588

[1] No observations at Chakrata. [2] No observations at Newera Elliya.

[1] Where any doubt exists, a mark of interrogation is affixed.

In the preceding tables G signifies the gradient at sea-level, g the gradient at 7,000 feet, P the pressure at the level of the neutral plane, and H the height of the neutral plane in feet. The gradients have all been corrected for the change in the value of gravity due to change of latitude, in accordance with the recommendation in my note on this point which was read before the Society in February, 1883.[1] The heights corresponding to the pressures at the level of the neutral plane are deduced by a careful method of proportion from those calculated by Herschel's method, from the means for several years; and are given at the mean temperature, instead of that for each year separately. With the exception of the error introduced by this latter arrangement, which would be very small, they represent with fair approximation the heights corresponding to the pressures. The stations utilised are the same as those employed by Blanford and Hill.

Before comparing the figures here given with evidence derived from other sources regarding the character of the monsoons in each year, it may be noticed that the range of the mean elevation of the neutral plane is nearly three times as large between Ceylon and the North-West Provinces as it is between Ceylon and Sikkim. This is in accordance with what might have been expected, when it is remembered that the range of monthly pressure is considerably greater in the North-West Provinces than in Bengal, and that in fact the former region constitutes the centre of the summer and winter monsoon systems, and therefore a region where the vertical range of the neutral plane of pressure reaches its maximum.

The figures in the preceding tables enable some estimate to be formed of the average height or thickness of the currents in the months which have been taken to represent the winter and summer monsoon systems respectively; and as the character of each monsoon in India follows pretty consistently that of its initial month (especially the summer monsoon, that of July, with reference to which Eliot says in his *Report on the Meteorology of India* for 1877, "There is a striking uniformity of the South-west Monsoon during the whole period of its prevalence"), the conditions during these months may be considered as typical of those which prevail throughout the contrasted seasons.

On examining the preceding tables for the last five years, 1876-80, during which the observations were trustworthy in both regions, it may be inferred from this evidence alone, that the summer monsoons in the North-West Provinces were deeper and more extensive than usual in 1878 and 1880; while those of 1876 and 1877 would appear to have been shallower and less extensive. In Bengal, on the contrary, it would seem as though these conditions were reversed, except in the case of 1880. As far as can be judged from a general inspection of the characteristics of each year described in Mr. Blanford's Reports, the monsoons in the years just mentioned were broadly characterised by these features. The depths of the winter monsoons would appear, from the figures for the heights of the neutral plane, to vary much

[1] *Quarterly Journal of the Meteorological Society*, Vol. IX. p. 125.

less than those for the summer; a fact which agrees with others regarding the greater constancy of the conditions during the former season from year to year. It is manifest, however, that we cannot expect to infer the character of a monsoon from a knowledge of its depth alone. A monsoon current might be of great depth, but of small average velocity and humidity; and several variations might be produced by different combinations of the three factors, depth, velocity, and humidity.

For the purpose, therefore, of arriving at some further notions regarding the physical character of each monsoon, I have sought to ascertain the mean height at which an ascending column of air would attain the dew-point, or, in other words, the lower limit of the region of condensation and cloud in the typical months of the years for which the height of the neutral plane has been obtained.

This has been approximately determined from the mean monthly temperatures and vapour-tensions at the Lower Stations, as follows:—

TABLE V.—HEIGHTS OF PLANE OF CONDENSATION ABOVE SEA-LEVEL.

	Bengal.		North-West Provinces.		Ceylon.	
	Jan.	July.	Jan.	July.	Jan.	July.
	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.
1870	..	..	..	..	1,258	1,503
1871	..	..	..	..	1,490	1,367
1872	3,316	2,227	..	..	2,477	1,801
1873	3,079	1,721 (?)	..	..	2,089	1,422
1874	..	..	4,618	2,819	2,172	1,015
1875	2,576	2,118	7,046	3,865	1,751	1,801
1876	3,257	2,804	6,658	3,517	2,117	1,666
1877	3,257	1,974	4,488	6,306	1,909	1,895
1878	3,286	1,757	4,444	4,341	2,588	2,018
1879	3,642	1,938	9,045	3,168	3,751	2,099
1880	3,138	2,299	6,788	2,668	2,643	2,376
Mean for several years[1]	3,375	2,118	6,088	3,420	2,145	1,638

[1] The means for Bengal are derived from 11-12 years' observations of temperature and 4-6 years of vapour tension at Goalpara. Those for the North-West Provinces are given by Prof. Hill in his paper on the Meteorology of the N.W. Himalaya in the *Indian Meteorological Memoirs*, Vol. I., and those for Ceylon are derived from the means for 10 years of both elements. The figures for the individual years have all been calculated by myself.

Before proceeding further, it may be worth while to notice one or two points brought out by these figures. In the first place, it is evident that the height of the plane of condensation in the damper climates of Bengal and Ceylon is much lower than in the drier climate of the North-West Provinces; and, in the second place, the variations from the mean are much less pronounced in the former regions than in the latter. This is particularly the case in the years 1877 and 1879.

In the former the plane of condensation was considerably below the average in January, and above it in July; while in the latter year these conditions were precisely reversed. The rainfalls of the corresponding monsoons in these years accorded with these characteristics, and in many other respects

the two years were typically contrary, especially in the North-West Provinces. In Bengal and Ceylon, on the other hand, the corresponding heights of the plane of condensation with those of the neutral plane in the same two years present scarcely any similar variation, except to a small extent in January. A reference to the summary of the weather of each year shows that the rainfall in Bengal and Ceylon hardly varied from the normal in these two years. As the character of the monsoon in any locality may be supposed to be partly regulated by the depth of the current, and partly by the position of the plane of condensation, leaving out of consideration for the present any discussion of the velocity, direction, and temperature of the air, I have, by subtracting the height of the plane of condensation from that of the neutral plane, in Table VI., approximately determined the thickness of the stratum of the monsoon current above the plane of condensation, or, in other words, the thickness of that portion of the monsoon current in which cloud would be likely to form.

TABLE VI.

Vertical Thickness of the Stratum between the Lower Limit of the Plane of Condensation and the Upper Limit of the Monsoon Current in feet.

	Bengal.		North-West Provinces.	
	January.	July.	January.	July.
	Ft.	Ft.	Ft.	Ft.
1872	6,993	5,861	....	....
1873	3,152	8,868	....	....
1874	No obs. of Vapour Tension		— 726 (?)	23,094 (?)
1875	4,369	7,914	—4,002 (?)	4,683 (?)
1876	4,241	6,624	— 862	8,135
1877	10,427	6,568	2,249	4,449
1878	3,910	5,975	635	10,729
1879	10,107	5,237	-1,420	9,150
1880	....	7,152	....	16,472
[1]Mean of several years	3,564	8,016	— 521	11,168

[1] *Vide* Note attached to Table III. regarding the period embraced by the means.

It may be inferred, with some degree of confidence, that the thicker this is, the greater is the probability of clouds forming and rain falling. That such is actually the case is rendered manifest by comparing the thicknesses of this stratum in the North-West Provinces for July with the averages, and with the recorded conditions in the respective years. Thus, to take the case of clouds alone, the following summary of the cloudiness of January and July in India, in the years commencing from 1876, may be compared with the figures in Table VI.

CLOUDINESS.

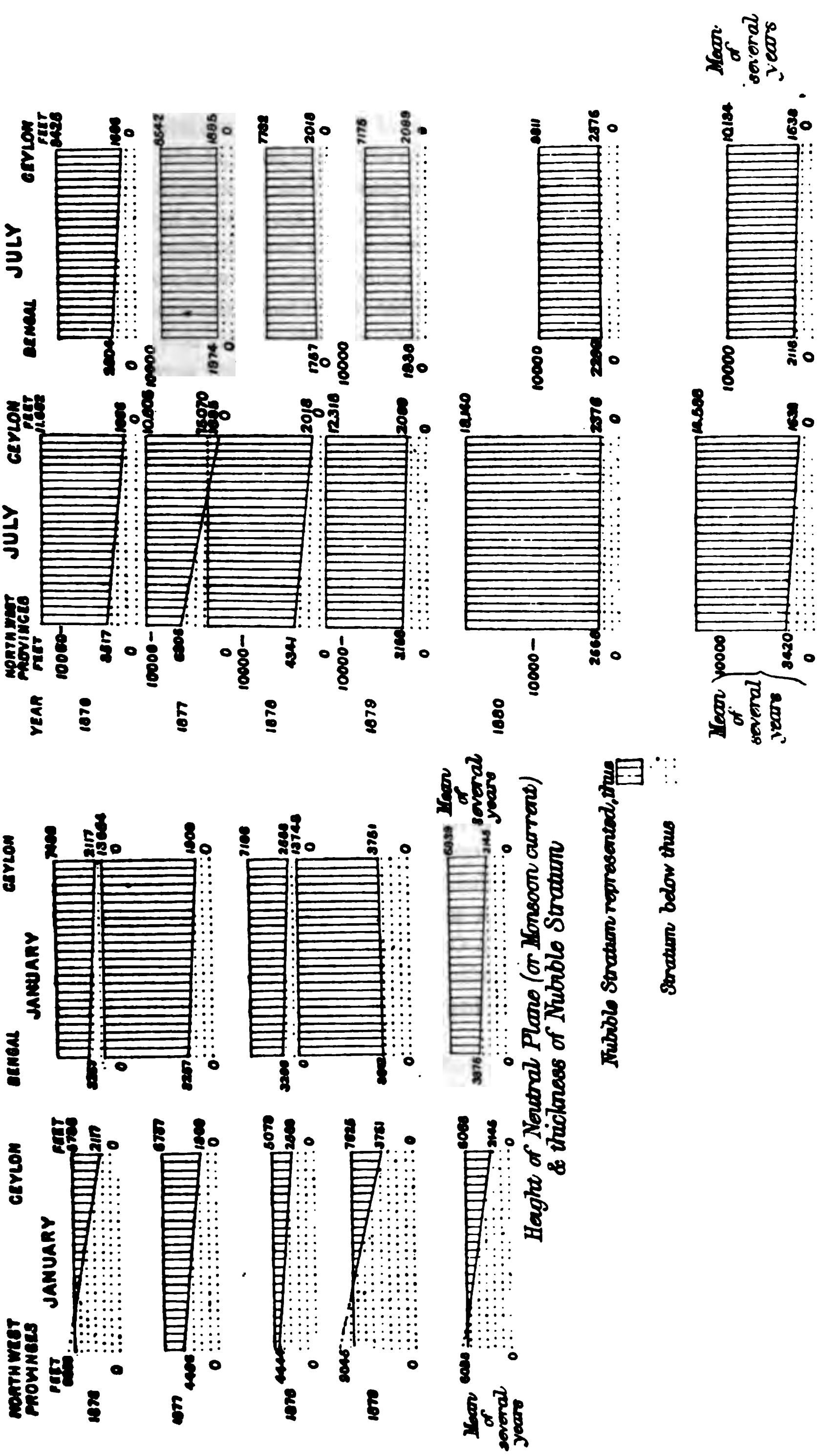
January.	July.
1876. Less than half the usual amount throughout the Gangetic Plain. In Punjab nearly the average. Much below in the Central Provinces and Bombay. Above the average in Upper Assam and the Eastern Himalayas.	Average in North-West Provinces, Bengal and Assam. Bombay and Ceylon below average.
1877. Sky much more cloudy than usual. Amount was considerably in excess over the whole of North India, except Assam. Excess most marked in the Central Provinces. In defect in South India and Ceylon.	Below the average, except in Behar, Bengal, and Orissa, Assam and Arakan. The defect was proportionally greatest in the Punjab, North-West Provinces, Rajputana, Sind, Gujerat, and the Malabar Coast.
1878. In North Western Provinces, Bengal, Orissa, and generally in the Peninsula and Ceylon, above the average.	In Punjab more below than in June, and in North-West Provinces nearly as much so. In Behar and Bengal, generally an excess. An excess in Ceylon.
1879. Except Darjiling and Silchar, all stations in Northern India unusually serene. In Ceylon a slight excess of cloud.	In North-West Provinces excess as great as in June. In Bengal excess was small.
1880.	In the North-West Provinces and Bengal, in general above the average. Elsewhere the anomalies not striking.

Except in the case of July 1878, in the North-West Provinces and January 1878 and 1879, in Bengal, the description of the cloudiness tallies closely with what might be expected from the figures for the depth of the 'nubible' stratum, as it may be termed. In January 1877 and 1878, and July 1877, this is especially the case; and it may be observed that while in the means for the North-West Provinces the minus sign shows that in January the plane of condensation usually lies above the neutral plane, in the two former years it lay below it; and that the occurrence of the abnormally heavy winter rains which characterised these years was accompanied by, and perhaps in a measure due to, this condition.

The figures likewise show that the range of variation in the thickness of the nubible stratum of the summer monsoon is considerably greater in the North-West Provinces than in Bengal.

As before stated, this was also the case in the heights of the neutral plane; but it is here rendered much more pronounced, both because the variations in the height of the plane of condensation are greater in the former district than in the latter, and because the conditions which cause this plane to rise, seem in the former region to coincide in point of time with those which tend to lower the neutral plane, and *vice versâ*.

Thus in July 1877, when the neutral plane was 3,783 feet below the average in the North-West Provinces, the plane of condensation was 2,886 feet above the average, with the result that the thickness of the nubible stratum was 6,669 feet below the average. On the other hand, in July 1880, when



Height of Neutral Plane (or Monsoon current) & thickness of Nubble Stratum

the neutral plane was 4,552 feet above the average, the plane of condensation was 752 feet below the average, and the resulting thickness of the nubible stratum 5,304 feet above the mean.

It would seem then, that if the height of the neutral plane in July be taken to represent some sort of measure of the volume and force of the summer monsoon, its pluvial character is liable to considerable variation in arid districts such as the North-West Provinces. When the monsoon is light, the aridity of the district being only partially overcome, the lower portions of the clouds are re-evaporated by the desiccated air below them, and so the general tendency to drought is augmented. When, on the other hand, the monsoon is heavy over such a district, the soil having once got well-soaked no longer acts like a drying oven, and the clouds are able to assume their normal depth and thickness. The preceding circumstances agree with the evidence that has been amply furnished from other sources in favour of the secondary connection which is now generally accepted by meteorologists as existing between vegetation and rainfall. Primarily, of course, the former depends more or less on the latter; secondarily it tends to promote it, and timber planting, when it could be effected in the North-West Provinces, would doubtless tend to preserve that region in a great measure from the disastrous famines to which, in common with Madras, it is periodically subject.

For the purpose of showing the variations in the height of the neutral plane, and those in the nubible stratum conjointly, I have represented them graphically in the diagrams (p. 185).

An inspection of these diagrams would lead to the inference *primâ facie* that in the North West Provinces the winter monsoons of 1877 and 1878 were unusually rainy, and that of 1879 unusually dry, compared with the average. Evidence from other sources proves this to have been the case. Turning to the plate for July, it might be expected that the summer monsoons of 1876 and 1877, if they followed their initial month, would be abnormally dry, since they show, especially in 1877, a more rapid thinning up than usual of the nubible stratum at its base, from Ceylon northwards.

July 1878 was also a dry month, and though the monsoon throughout was in other parts accompanied by heavy rains, it was not heavy in the North-West Provinces.

In 1879 it would be inferred that the summer monsoon in the North-West Provinces was nearly normal, and in 1880 excessive. The summer of 1879 appears to have borne out these characteristics; but in 1880, though there were locally excessive falls of rain in the North-West Provinces, the monsoon cannot be said to have corresponded in general to anticipation from its unusual depth in the diagram. An inspection, however, of the pressure conditions during July, as given in Blanford's Report for 1880, shows pretty plainly that the abnormal height of the neutral plane for this month arises from the marked opposition in the pressure anomalies at the higher and lower level.

Thus the mean of four hill stations and four adjacent stations on the plains in the North-West Provinces, with that of the stratum between, estimated by taking their joint averages, gives the following results:—

	Mean Pressure Anomaly, July.
	In.
Hill Stations	− ·015.
Intermediate	+ ·022.
Plain Stations	+ ·007.

The high pressure on the plains would tend to decrease the sea-level gradient, while the low pressure of the hill stations would tend to increase the gradient at 7,000 feet; and so while the lower atmospheric strata were denser than usual, and the isobaric planes closer together, those at the higher elevations were raised considerably above their usual level. The monsoon was thus of an irregular type, and appears to have been characterised by a general precipitation below the average, accompanied by locally excessive rainfalls.

In the case of Bengal, the diagrams of the summer monsoon generally bear out their recorded characteristics, and it may be noticed that when the monsoon was moister than usual, as in 1877, 1878 and 1879, the height of the neutral plane was lower than usual, contrary to what generally seems to hold in the North-West Provinces. It would be unsafe, however, to draw any conclusions from this, as the period is too limited.

It would have been more satisfactory to have arrived at some fresher and more valuable deductions from the data employed in this paper. It must, however, suffice for the present to leave this to other hands.

One marked and peculiar relation has been observed by Blanford, Hill and others, to exist between the meteorological conditions which precede and those which accompany the Summer Monsoon. Thus, to quote from a recent article by me in *Nature* (Vol. xxviii. p. 480), "In years of heavy winter rainfall in Northern India, and therefore of heavy snowfall in the Himalayas, an excess of barometric pressure attended by diminished temperature is found to occur during the earlier months of the year, which causes the air to move outwards from the centre of relatively highest pressure, and so bar the approach of the Arabian Sea current from the South-west, as well as the Bay of Bengal current from the South-east; and by thus compelling them to part with their moisture in other districts, such as the hills of Central India or East Bengal and Burmah respectively, causes deficiency and drought over the Punjab and North West Provinces, or Western Bengal." A good example of this was furnished by the year 1877. "On the other hand, in years of defective winter rainfall the temperature is generally high, and the pressure low, in the early months of the year; while the currents from the South-east up the Ganges valley appear in full strength, and are accompanied by early and abundant summer rains."

Mr. Blanford has partly attributed the high atmospheric pressure which occurs in the years of heavy snowfall to the cooling thereby produced, but as this abnormally high pressure sometimes extends as far as the Bombay coast, and occasionally, as in 1876-1877, throughout Asia and Australia,

local causes seem inadequate, such as the suggested one that the air is cooled by the Himalayan snow-fields, for the full explanation of such widespread anomalies.

Now the suggestion which I desire to put forward, is to the effect that these large variations of pressure over the Asiatic area are closely related to, if not actually dependent upon, those in the Atlantic and Pacific areas.

The synoptic charts of Buchan and Ferrel show that on the mean of the year, and especially in the winter months, the distribution of pressure is anticyclonic over North America and Asia, and cyclonic over the North Atlantic and Pacific areas adjoining. In the winter this tendency is very clearly shown on its proper scale in the excellent polar projection, Chart V. of Mr. Ferrel's *Meteorological Researches*, Vol. I., from which it appears that the centre of one of these constant polar cyclones lies in Iceland, and that of the other near Behring Strait.

Corresponding to these, anticyclones exist, whose centres lie symmetrically over Asia and America in a line at right angles to the line joining the cyclonic centres. If Ferrel's theory be accepted that every cyclone is accompanied by a corresponding anticyclonic ring, which forms a necessary appendage to it, the conclusion follows that the anticyclonic systems over Asia and America in part, if not altogether, belong to the oceanic cyclonic systems, and vary correspondingly with them. Consequently the deeper and more unbroken the cyclonic areas are, the higher should be the pressure over the anticyclonic areas, and *vice versâ*.

Now from the spring of 1876 to the autumn of 1878 the pressure over Asia, and more especially Indo-Malaysia, was abnormally high, and was, as Mr. Blanford has shown,[1] an abnormal phase in a periodic barometric anomaly which appears in opposite phases in Siberia and Indo-Malaysia.

Corresponding to this abnormal anticyclone over Asia, it is shown from General Myers' synoptic charts, as well as other sources, that there was during the same period an unusual development of the North Atlantic cyclone, giving rise in these islands to the warm and wet winters of 1876-77 and 1877-78.

Whether the summer pressures over the Atlantic showed similar characteristics is not so plain; but it is significant to observe that, according to the evidence furnished by Mr. Blanford in his article in *Nature* just referred to, "both the smaller periodic, and the greater non-periodic elements of the variation appear to depend mainly, if not solely, on the variation of pressure in the winter season;" since it is precisely at this season that the oceanic cyclones are most developed, and therefore their complementary anticyclones likely to be most affected by their variations.

Another point, namely, the fact that the high pressure over Indo-Malaysia has in one case been actually traced to be, and is probably (from circumstances which Mr. Blanford has brought out in recent reports) always due to the condition of the upper strata, is favourable to the same notion, since

[1] *Report on the Meteorology of India* for 1878, and *Nature*, Vol. XXI. p. 477.

the air thrown out from the Atlantic and Pacific cyclones must descend from above, and thus affect the atmosphere in the anticyclones primarily in their upper strata.

There are several other facts, all converging favourably towards the hypothesis of which I have just ventured to give a rough sketch. It may, however, suffice to state that there is preliminary evidence to show that the relation has an average period of eleven years, and that the cyclonic and anticyclonic tendencies oscillate between the oceans and continents (leaving out the Pacific area, about which there is little or no evidence in the past) in something like the following manner :—

Years.	Characteristics.
1821-2-3-4 1833-4 1844-5 1866-7 1875-7	Mild, wet, stormy winters in Europe, unusual cold in Iceland and America, great drought in India. Atlantic cyclone and Mid-Asiatic anticyclone more developed than usual.

Years.	Characteristics.
1829-30 1838-9 1859-60 1870-71	Cold, dry winters in Western Europe, warm in America, good rainfall in India. Atlantic cyclone and Mid-Asiatic anticyclone less developed than usual.

I hope hereafter to work this question fully out, being persuaded that the more rapid oscillations of pressure accompanying the passage of the smaller cyclones and anticyclones which prevail in these and other localities, can only be understood and predicted when the meteorologist has a due knowledge of the movements, changes, and causes of the larger pressure areas in which they take their rise, and by which they are guided in their course. Moreover, in India and other countries in the tropics, where the character of an entire season depends, not as here on the number and intensity of cyclones and anticyclones travelling over it, but upon the position and intensity of large and nearly fixed areas of high and low pressure, it is obvious that a foreknowledge of the character of the latter would be of great value, and would far outweigh any of the more local and minute changes which it might be possible to forecast concerning the former.

THE SUNSETS AND SUNRISES OF NOVEMBER AND DECEMBER, 1883, AND JANUARY, 1884. By the Hon. F. A. ROLLO RUSSELL, M.A., F.R.Met.Soc.

[Read February 20th, 1884.]

ON November 8th, 1883, there was a fine sunset, the yellow and red light in the South-west appearing to be reflected from straight horizontal thin streaks of cirrus. Long after sunset and till nearly dark there was a pink glow from what was then supposed to be a "very high filmy cirrus."

On November 9th, about and before 7.30 a.m., similar "high pink filmy cirrus" was seen.

About 10 minutes before sunset on this day, the sky being very clear and deep blue, with the exception of a few fleeces of cirrocumulus nearly overhead, the sun turned unusually white and descended in a slight haze, with a remarkable greenish white and yellowish white opalescence on the upper part. About 15 minutes after sunset the sky up to about 45° from West-south-west by South, from a few degrees above the horizon turned a brilliant but delicate pink. Below this a shining green and white opalescence hung like a luminous mist. The order of colours from the horizon was green, bronze yellow, and pink. The coloured portion of the sky spread out in the form of a sheaf or half-opened fan from the horizon, and resembled a very high thin filmy cirrus disposed in transverse bands or ripples, close together, and exceedingly delicate in form, outline, and tint, but no cloud had been seen there previously. The illuminated matter "seemed not to belong to clouds, but to glow of itself like some super-atmospheric film," and yet the idea of an extra-atmospheric cause could not be entertained as consistent with its later behaviour. The strange effect grew with increasing darkness, and at 5 p.m. the glow shed a fine light on the hills eastwards. The moon was now shining brightly. About this time the colour was seen to be slowly receding from the part nearest the zenith (about 80°) towards the Western horizon, leaving a clearly visible filmy ripple of a soft grey tint. At 5.25 p.m. the colour remained bright only near the horizon, but now it seemed to grow up again, and in a short time (5.32) the whole extent of the film was again glowing bright pink, producing a striking effect with moon and stars. The rosy light after about 5.40 slowly withdrew towards the horizon, remaining deep red there till 5.50. At 5.58 it was all gone.

Throughout the duration of the display, the margin was as well defined as that of soft clouds against the blue sky, and there was not the slightest illumination of the sky elsewhere, except in some long streaks stretching apparently from South-west to North-east above the Southern horizon. One striking feature was the complete absence of any movement in the filmy matter from which the glow proceeded, its position and shape remaining exactly the same all through. This led me to suppose that it must be some kind of cloud in a region where none had hitherto been observed. The opalescent mist, which was so strange and brilliant in the first twenty minutes, seemed, on the contrary, to hang at no great elevation.

On November 10th, at 6.20 a.m., although the sky was cloudy, there was a clear space in the East, where a peculiarly pink sunrise light was seen. About 3.30 p.m., as the sun sank lower, a very thin high rippled haze became visible in parts of the sky, especially in the South-west. About 4.32 this became more distinct, as it began to glow with sunlight in the clear sky after sunset (4.19), and turned bright pink; this colour lasted till 5.10, occupying only a small part of the sky. "As the light faded off, the film entirely disappeared in the deep blue sky." The small illuminated ripple lay to the left or South of the place of sunset, up to about 25° at most from the horizon, and shone very faintly compared with that of the previous day, which was far larger and more Northerly in position.

On November 11th there was pink cirrus in the East at 6.10 a.m. At 11 a.m. an iris, due to increasing cirrostratus, was seen round the sun.

From this date till the 23rd, the sunrises and sunsets, when seen, were not obviously remarkable.

On November 23rd the sun seemed to set in ill-defined striæ of cirrostratus or cirrus, and on the 24th the striæ were yellowish green.

On the 25th the sun set in hazy striæ. A green light was seen above the place of sunset, and a bright greenish-white glow growing from about ten minutes after sunset; above the greenish-white there was pale red. The sky shone somewhat as on November 9th, but much less strongly. The glow lasted about 45 minutes.

On November 26th the glow was stronger, and lasted nearly an hour, bright red.

On November 27th and 28th the duration of the glow, which resembled that of the 25th, was about an hour and twenty minutes.

On November 29th the colours from two hours before sunrise are said to have presented a wonderful spectacle in London. In the evening some redness could be seen through a break in the clouds at 4.55 p.m.

On November 30th, at 6.5 a.m., there was a fine deep red glow in the East. This spread quickly upwards, and had turned yellow by 6.40. At 6.24 the faint redness extended to the zenith. There was no cirrus visible, but the cirrocumulus remained tipped with dull red from 6.5 to 7.44, when the sun rose.

On December 4th and 5th the sky was clear, and its appearance in the mornings and evenings was most interesting and strange in many respects.

The succession of colours and the whole character of the displays, on every occasion during December and January, were in general agreement with those first observed, though the matter concerned seemed gradually to become thinner and the cloud-like detached form of Nov. 9 did not occur again.

Usual Order of Phenomena. Sunrise.—A red glow above the Eastern horizon, indefinite in outline, rose up quickly towards the zenith, and turned yellow within half-an-hour, covering the sky and all objects facing East with a peculiar glare of twilight. After about 50 minutes from the first appearance of this glow, there was another but a much stronger glow of a deep red colour on the East-south-east or South-east horizon. This commonly grew up rather quickly towards the zenith, making the sky appear as if veiled with a thin pink haze, and in about twenty-five minutes more the sky and earth were strongly illuminated, the brightest stars disappearing. A bright green spot now came into view from about East to South-south-east, a little above the horizon, and this remained till sunrise, the pink above it changing to orange-pink, orange, and yellow. When the air was favourable, a third glow, which was the ordinary one, would appear on the horizon a few minutes before sunrise. After sunrise, a kind of white sheen or glare surrounded the sun, and the sky often remained greener than usual in the distance.

Sunset.—The inverse order of phenomena took place at the setting of the sun. Standing on an elevated spot, with a clear view in all directions, and

favoured by a perfectly clear sky, the following was observed to be their regular succession in England and Italy :—A greenish or bluish-white spot or arc immediately after sunset above the sun, often surrounded by a brownish or pinkish ring. This was often bright for at least half-an-hour, but declined Westwards. Between ten and twenty-five minutes after sunset, according to locality and date, a rosy glow in the East. This glow ascended and passed right across the sky Westwards, of course becoming much less conspicuous overhead, or even invisible. It generally passed the zenith from twenty-five to thirty-seven minutes after sunset, and no uncommon light was ever left behind the red. Little, if any, of the green glare would now remain in the West, but it would still be shining on the under surfaces of any clouds present. The Western horizon was now surmounted by a yellow or orange arc, which always followed the green, and the pink was gradually contracting on its outer edges. Soon after the rosy light passed the zenith, it sometimes produced a beautiful lilac or purple veil by mixture of its light with the deep azure, but whenever the film was dense, and the display grander than usual, the rosy colour predominated. The yellow arc sank Westwards, becoming deeper in colour, and the pink, being the outside colour, became more and more conspicuous as darkness increased and the brighter colours set out of sight. When only a broad red band or bank remained above the horizon, the Eastern sky, which had turned dark blue, quickly assumed a greenish, bronze or brownish hue, and soon this secondary light also passed overhead and hung like a faint luminous orange or pink haze in the Western sky, the first glow having passed out of sight. The East was now dark and the stars bright. The secondary glow slowly sank Westwards and disappeared like the first, generally becoming in its descent more conspicuous, and deeper coloured.

The arc in East or West at sunrise and sunset was always more or less green in the inner, yellow in the middle, and pink in the outer parts. The edge of the glow was sometimes nearly as definite as that of a soft cloud, but on other occasions the luminous haze gradually thinned off so as to be quite indefinite. Sometimes the glowing mass was surmounted an hour or so after sunset by diverging shafts or rays, but this did not often occur, and nothing of the kind was seen before sunrise. The sky was free, except on one occasion, from any appearance of shadow-beams, and cirrus was unusually rare during the period.

The variety of new tints was almost endless; but on the whole the main order of procession of colours was similar to the gradation seen in a fine autumnal sunset, when the clouds change from yellow through orange to pink, red, and crimson. The green or bluish-white, however, which preceded the yellowish-green and yellow, was a new feature, at least in its intensity, and must be considered in connection with the colour of the sun about thirty or forty minutes before setting, and its colour in India, the Soudan, on the Gold Coast, and in the West Indies. It seemed to affect that part of the sky where the sun's light would be shining through a maximum quantity of the foreign matter, and not a very great depth of

vapour. For while the ordinary vaporous air arrests chiefly blue waves, causing the sun to set red, the foreign matter seemed to stop and scatter the yellow and red waves. Thus the green would pass through with the least loss.

Effects of Colour on Clouds and Terrestrial Objects.—The effects of colour on the lower and upper clouds, and on such objects as domes, steeples, buildings of all kinds, and trunks of trees, were very peculiar and sometimes unearthly, but, on the whole, easy of explanation. Soon after sunset, and perhaps for half-an-hour or more, the dominant and brightest light rays came from the greenish-white spot or arc near the South-west horizon. While the twilight remained strong this colour would not show itself strongly on objects exposed to it. But after a short time the yellowish light was added to the green, and then in the increasing darkness all objects facing West reflected a sort of lemon or sulphur tint, which was all the more striking when seen against a rosy Eastern sky. The clouds, especially detached cumulus, all over the sky, then looked quite green, often not only at the edges. And this was not a subjective effect, as might have been supposed if the distant Western sky were not in view. It was owing to the bright greenish spot above the sun's place still shining upon the lower surface of the clouds, the upper yellow and red being cut off by the thickness of the clouds. The result was that on several occasions a sky suffused with pink was dotted with green clouds. No doubt physiological action might increase the intensity of the green. The clouds on no occasion appeared blue on the orange sky, which was nearly as common as the pink, but always green while the illumination was passing across. Frequently the green light near the horizon was only sufficient to tinge the clouds greenish for a short time, and the reflecting matter insufficient to hide the celestial blue overhead with glowing pink or orange. Then when the green spot had sunk well below the horizon, the increasing brightness of the red in perspective, and its place low enough down to illuminate the under surfaces of the clouds, gave the spectacle of pink clouds floating for an hour or more on a blue or green sky. (The sky became greenish in the East, as before mentioned; on the advent of the secondary glow.) If the clouds were suitably placed, they reflected the red light from the glowing red when this had sunk for some time out of view, for a mass of cirrus over the Western horizon would catch the rays from the glow much later, and reflect them very visibly to nearer clouds in the greatly increased darkness.

Colour of the Moon.—When the moon was surrounded by and seen through a pink and orange haze, it appeared blue, but this effect was chiefly subjective, as if it had not been there would have been no reason why it should not remain blue when the bright colour left its neighbourhood and after dark, but in fact it resumed almost its ordinary light. However, on several occasions, the moon was slightly green all the evening, and this was doubtless due to scattering by the reflecting matter. The green colour was most apparent at an altitude of one or two hours. The moon, on the many clear nights when it was seen, even when the sky-haze was most dense, was free

from any appearance of halo or corona, such as surrounds it when its beams are intercepted by high cloud or mist.

Appearance of the Stars.—The stars shone as brilliantly as if the sky were perfectly clear, and yet, on the days of maximum glow, the first light from the horizon was sufficient to make it appear completely overclouded. The bright stars in the West shone through the illuminated mist until about half-an-hour before sunrise. In Italy and the South of France, the colour of the stars was decidedly greener than usual at night.

Colour of the Sun.—The sun was commonly of the usual red colour at rising and setting, but when about fifteen to forty-five minutes (time) above the horizon often looked either white (like the electric light) or of a very pale yellow colour. At about this elevation it looked green through a dark telescopic glass. In Italy, towards the middle of January, the sun soon after rising sometimes shone with a slightly greenish yellow light. In England, when the atmosphere was in such a condition as to make the sun nearly white in setting, as in the white mist accompanying gales, the whiteness was exaggerated by the elevated foreign matter.

Duration of Twilight.—The duration of strong twilight was prolonged by from fifteen to thirty minutes. Thus on December 19th, at Eastbourne, the sun rose at 8.5 a.m., but at an East window there was plenty of light to read by at 7.10, and even on January 28th, when the illumination was much fainter than in December, it was possible to read thirty-six minutes after sunset. On some foggy and cloudy evenings and mornings, December 27th and 30th, the twilight was pink, and on November 30th it was greenish through rain.

Sunset and Sunrise compared.—In general, but not always, the colours after sunset were brighter than before sunrise. The pale green with a pale pink margin lasted longer before sunrise without change, but the red bank lasted longer after sunset. The blood colour was often wanting before sunrise, but hardly ever after sunset. Thus, in fine weather, the red would occupy a large space with strong colour in the evening, but a much less space with fainter colour in the morning. The red on some mornings was grandly conspicuous, notably November 29th and 30th and December 4th and 5th. The brilliancy of the colours did not vary with the weather, except in so far as actual cloud or mist at some elevation interfered with the reflection of the less refrangible rays; thus, on cloudy days the yellow, but not the red, could be seen through rifts.

Distribution of the Matter concerned in the Production of the Sky-glow.—On November 8th, when the prolonged glow of a portion of the sky in the South-west was observed on the southern border of Surrey, it showed the sort of stratification in thin streaks which often appears in cirrostratus, but its elevation was evidently greater than that common to this cloud. On the 9th, although the sky was perfectly clear of cirrus and other clouds except a little cirro-cumulus, both at and long after sunset, yet when the sun had set about fifteen minutes or a little more, the South-western sky became illuminated, and this illumination appeared to be the reflection of sunlight, though of a

character not hitherto observed. Its brightness was too great for the zodiacal light. It was of too red a colour, and the other colours nearer the horizon seemed to belong to terrestrial matter. As the glow slowly receded, it became possible to distinguish near the zenith some slight film of the flimsiest kind, disposed in ripples nearly transverse to the sun's rays, and now of a grey tint on a dark blue sky. The glow much resembled a fine display of aurora borealis, but there was no flickering or rapid movement, and as soon as it became evident that the light was regularly following the sun's course, the idea of aurora could not be entertained. About 7.30 a.m. on the 9th, and 6.20 a.m. on the 10th, a similar pink light affected the Eastern sky. On November 10th the sky was very clear after 9 a.m., with a fresh West-north-west breeze, and gave a good opportunity for observation. As the sun declined, about 3.30 p.m., a very thin hazy ripple was seen in some parts, especially South-west. About 4.32 this grew more distinct, and was soon of a pink colour, which lasted till 5.10, showing while coloured a transverse ripple like that of the day before, but the glow was very much fainter. On November 23rd, 24th, and 25th, the sun set in a kind of haze of thin striæ, a peculiar green colour distinguishing that part of the sky. On November 30th the illumination before sunrise was very fine, and it became evident that the sky was covered by a thin mist at an elevation much greater than that of the highest cirrus, but no structure or variations of density were made out. On the morning of December 4th, which was clear and cloudless, the structure of the reflecting matter showed itself at 6.30 a.m. with great distinctness, and at 6.45 a.m. could be seen over a large part of the sky. It had the appearance of a thin misty cloud of some sort, disposed in long streaks stretching from about West-south-west to East-north-east, with here and there an irregular patch across the wavy surface. Towards the North-east, where the streaks were seen almost endwise, the effect of a fretted hanging wavy mist, quite motionless, was produced. Long watching failed to detect any motion in the streaks. As the reflected light passed Westwards the sky again became blue, and just before the advent of the primary, or second, glow the cloudy streaks had nearly vanished. They now were lighted up again as the primary glow rose on the horizon, 6.55 a.m., and at 7.28 the sky overhead and towards the West was faint pink, covered with large billowy streaks and patches, without fibrous structure. This cloudiness was sufficient to hide the blue sky, but in full daylight only faint traces remained visible. At 7.50, and for some time after, the streaks were again conspicuous with the ordinary illumination of sunrise. Twelve minutes' watching failed to make out in the streaks any progressive motion, though the bulk of some of them slightly altered. The sun rose at 7.55 a.m. of a red colour, but in about half-an-hour was pale steel bluish white, surrounded by a silver white sky with a slight bluish tinge. During the day the billowy haze was faintly visible on the blue sky. As the sun was setting, about 3.58 p.m., this haze became so white that the sky looked quite clouded by it. At sunset the haze was disposed in very large billows without perceptible motion, lying about South-west to North-east and crossed

in some parts by a thick streak nearly at right angles. About 4.12 the spot above the sun's place shone with the colour of bright steel or freshly cut lead, and the parts round it with a metallic pink. About 4.20 the forms of the haze billows or streaks were lost in the uniform rosy glow. As the ruddy glow sank Westwards the sky seemed perfectly clear without a trace of the haze. As soon as it approached the horizon, however, the sky again became mottled and assumed a pale straw colour. Later the moon and stars gave no indication of a haze canopy.

On the morning of December 5th the film appeared more uniform and less streaky, so as to be hardly distinguishable. The sun set in hazy striæ.

In the sunset of December 7th, it was observed that the cirrus turned pink a few minutes after sunset (3.50), and remained pink in the West till nearly 4.24, when it had lost all colour. The yellow glow began in the South-west at 4.20, and the cirrus turned black against it about 4.24. At 4.25 long streaks of the sky-haze came into view along the Western horizon, lighted up by the setting sun. At 4.31 the reflection from the sinking glow again touched the cirrus with a faint pink light, so that it shone a second time. The glow disappeared at 4.44, but the cirrus in the West caught some of its light till 5.5. It seems that the reflecting matter in the West first shone with the rays of the setting sun between twenty and twenty-nine minutes later than the cirrus above which it floated.

On December 11th the sky was perfectly clear and cloudless about an hour before sunrise, except a little detached scud. At 7.21 a.m., as the light of the primary glow spread to the zenith, the sky was seen to be striped with very high filmy streaks in the South-east. At 7.32 this appearance extended over the North-west. Obtaining a good view of the streaks in the South-east at 7.20, I tried to discover their motion. After about ten minutes' watching, one of them showed a translation from West-north-west of about half an apparent solar diameter in that time. At 7.35 and 7.40 the whole sky being covered with these long thin stripes, like the "billows" of a few days before but not so wide, it was found that they extended on all sides from South to North or South by West to North by East. One point seemed worth notice. Those in the extreme West, that is 10° or so above the horizon, as well as in the East, did not appear, like ordinary cirrus lines, to radiate from a point on the horizon. On the contrary, they were all seen to be lying obviously in the same direction, and the stripe furthest to the West gave nearly as good an idea of its true direction as a stripe overhead. The eye made the necessary allowance for such appearance of convergence as there was, and they were at once seen to be parallel. Between 10 and 11 a.m. cirrus strips without obvious fibrous structure, semi-transparent, were seen in the West and South-west. They were moving longitudinally from North-west to South-east at the rate of fully one and a half apparent solar diameter per minute. At 1 p.m. the streaks of sky-haze reappeared, stretching from South-south-west to North-north-east, and were watched without any motion showing itself, though when looked at after the lapse of fifteen or twenty minutes they seemed to have moved a little

transversely Eastwards. Their very indefinite appearance in the daytime made exact observation difficult, and at times the strong sunshine seemed to obliterate them altogether. Overhead the incidence of light would not allow them to appear. Between 12.45 and 3 p.m. the sun was surrounded by a broad steel-white halo with a wide border of pale pink. At 2 p.m. a stripe of sky-haze in the South-south-east was watched for ten minutes, and no motion either transverse or longitudinal manifested itself. The sun set at 3.49. At 4.15 the whole sky appeared to be covered with a sea of streaky cloud film, regularly ranged South-south-west to North-north-east, not showing a radiant point like cirrus on the horizon. At 4.36 the ulterior edge of the pink glow was about 15° above the horizon, and the sky clear blue. At 4.41, when the edge had sunk to about 10°, the sky began to be lighted up by it from below and to appear cloudy again. At 4.48 the blood-red colour extended to about 7° above the West horizon, some cirri in the East were dull pink, the moon very slightly bluish. At 4.55 the last red of the primary glow disappeared and the secondary was just passing the zenith. The secondary repeated less brightly the phenomena of the primary, and after showing a fine red arc at 5.18, finally disappeared at 5.33.

On December 12th there was much complicated cirrus and cirrostratus moving fast from North-west, and a great quantity of thin striated cirrus haze veiled the blue sky, making a misty appearance. At 3.45, however, a little of the high reflecting glow-matter could be discerned with the greatest difficulty in the North-west, stretching about from West-south-west by South to East-north-east by North.

On December 15th there was a yellow glow in the South-east at 6.18 a.m., which grew up as usual. The sky was very clear, with a bright greenish moon in the West. The moon did not show the slightest halo or corona during night or morning. At 7.40 the sky was seen to be streaked with haze billows as on previous days. The Western sky showed this marking very clearly, but it quickly faded towards sunrise. It remained visible, however, in the South-east over the sun for a long time, at least three-quarters of an hour, after sunrise. The Western sky at 7.40 resembled an ocean covered with regular billows. Some spaces, however, were clear. From 8 to 8.30 a.m. half-an-hour's watching of streaks in South-south-east failed altogether in detecting the slightest general movement, though there was a slight change in the bulk of one of the streaks. After the sun had risen about a quarter of an hour, the stripes in the West-north-west again grew quite distinct, but did not, as with the light of the primary glow upon them, hide the blue of the sky.

On December 16th, between 11 and 12, the sky, being very clear, could be seen on close scrutiny to be striped with haze billows near the sun and in the North-west. The striations near the sun appeared to be lying West to East, those in the North-west to be South-west to North-east. No motion was made out in fifteen minutes' watching.

About 3.43 p.m. the striation came out in the West where the sky was clear from the fast-driving cumulus scud, and there was consequently reason

to expect a fine sunset. At 3.57 it was evident that the striæ were not all lying parallel. On looking closely at the striæ in the South-west above the sun, they seemed to cross one another almost at right angles, and a curious sort of chess-board effect was thus produced. The incidence of sunlight brought out those in the South-west by South which were lying West-north-west to East-south-east most distinctly, and those in the West which were lying about South-south-west to East-north-east. I may mention here that a similar checked appearance occurred at Cannes on January 11th and 13th about sunset, the stripes lying about South-west to North-east and West to East; also on two or three other occasions, somewhat resembling watered silk or still more the zigzag marking sometimes seen on steel instruments.

On December 17th the striated haze was again seen.

On December 19th, at Eastbourne, there were striæ in the East long before sunrise, and about sunrise the blue sky began to appear to be covered with a very thin billowy haze, stretching about West-south-west to East-north-east. This went off with increasing daylight, a quantity of thin cirrus very similar in appearance, but differently disposed and moving fast, simultaneously increasing in distinctness. At 3.40 p,m. the wavy haze reappeared.

On December 20th it was seen about half-an-hour after sunset, the waves regularly disposed, but not all in the same direction in different parts of the sky.

On December 23rd, about 4.30 p.m., the clear sky between the zenith and the horizon became as if veiled with a very delicate structureless mist which completely hid the blue. At 4.35 the glow may have been at its highest point about 35° or 40° above the horizon, and showed strongly marked radiant spokes from the sun as centre of a most beautiful pink colour. At 5.5 the secondary glow extended nearly to the zenith. Probably these ray effects may have been due to the presence of scattered clouds, including cirrus and cirrocumulus, beyond the horizon. It was remarkable that the whole pageant of a fine ordinary sunset with high cirrus, lasting half-an-hour, was over before the unusual display began.

The hazy streaks were watched in a clear sky on January 24th about 11 a.m. in the East-south-east and in proximity to the sun, but no motion could be made out in fifteen minutes, though the streaks seemed to alter somewhat in configuration.

As the stratum of matter became attenuated, it was less and less visible, except in the neighbourhood of the sun and immediately after sunset.

Between November and February the sun was frequently seen to be surrounded by a glare of which the inner part was white and the outer pale pink or lilac.

The following are the marks distinguishing the peculiar sky-haze from cirrus:—

1. It is commonly much more equally spread over the sky than cirrus.

2. It is visible (except when very dense or in the neighbourhood of the sun) only about the time of sunrise and sunset. During the day not the faintest trace obscures the clear azure, whereas cirrus becomes more distinct with more daylight.

3. It has no perceptible motion, unless perhaps when watched through a long period.

4. It does not interfere with the clear definition of the moon or brilliancy of the stars.

5. It lies almost without exception in long streaks, stretching from between South and West-south-west to between North and East-north-east.

6. Its radiant point lies not on the horizon, but far below it.

7. If both cirrus and sky-haze be present, the sky-haze begins to shine with a red light soon after the cirrus has ceased to glow above the Western horizon. When cirrus is present, however, there is in general a reaction of effects.

8. The sky-haze is destitute of the fibrous twists and angular branches of cirrus, and, since the sunlight leaves it in regular progression, it must be stratified at the same uniform level.

9. It has always been visible on every clear day for more than two months (January 22nd), and has been quite independent of wind and weather.

Comparison of the above Data with Observations taken in Italy.—From January 3rd to January 11th I had an opportunity of seeing how far the order of colours, and what may perhaps be fitly called meteors of the sky in Italy, corresponded with those seen more than a month before in England. The correspondence was complete. The sheen surrounding the sun towards rising or setting, the bluish or greenish white spot, the yellow, the pink, the red, were all seen in the most favourable conditions possible. The intensity or thickness of the reflecting stratum was certainly much less than at the end of November, but the purity of the atmosphere permitted the less brilliant colours to display themselves in superb magnificence.

Soon after sunset there was the yellow glow at all times common on fine days along the Western horizon, but above it there was a peculiar bluish-white sheen which continued to throw for a long time a strong light on objects facing it. The streaks of sky-haze were generally most apparent about this stage, but being much less dense than formerly, the quarter opposite to the sun never showed a trace of it either at sunrise or sunset. The ordinary sunset glow soon disappeared, and the South-western sky assumed a green colour. The sky overhead and Eastwards was intense clear blue. In a few minutes the East was rosy, and then the rose colour passed overhead Westwards, leaving the Eastern quarter deep blue. The inner part of the arc in the South-west was green, the next band brilliant yellow, and this mixed itself with the rose colour, which became more and more foreshortened. For a short time the yellow greatly predominated, and the Western faces of white houses on the hills shone like primroses against a hyacinth sky. The green was soon below the horizon. The yellow deepened into orange, and contracted. When the rose colour had just passed the zenith, and for some time after, it had the appearance of lilac or purple, owing to the reflecting matter being exceedingly thin and allowing the blue colour of the sky to mix with its own. The

evening star sparkled like a small blue gem in this violet haze. At last, the more refrangible colours being all below the horizon, the whole arc glowed with a red light and so sank slowly to the horizon, fifty minutes after sunset. In this last stage, a curious discoloration (browning or greening) of the Eastern sky announced the presence of the secondary glow, and when this had passed over and attained a position between the Western horizon and about 30° altitude, it appeared as a beautiful faint rosy veil through which the stars shone blue. It disappeared on the horizon due West at one hour and twenty-two minutes after sunset.

The streaks of sky-haze whenever observed were lying about South-west to North-east as in England, so that their length was nearly parallel to the rays of the setting and transverse to the rays of the rising sun. As might be expected from this, the streaks themselves were better seen at sunrise than sunset, but being probably only thickened portions of an immensely extended film, the difference in the effects of sunrise and sunset were not considerable except in brilliancy of colour.

TABLE I.

Duration of Primary Glow on Clear Nights. (Time visible at all above horizon.)

Date.		Remarks.	Minutes.
Nov. 9.	Sunset.	Long matter stream	69
,, 10.	,,	Patch above horizon	53
,, 26.	,,	Cloudless. Amorphous	55
,, 27.	,,	Cloudless, Amorphous, except slight cirrus	
,, 28.	,,	Cloudless, except slight cirrus	75
,, 30.	Sunrise.	A little cir-cum.	60 ?
Dec. 1.	Sunset.	Amorphous. Strips of Cloud near horizon	
,, 4.	Sunrise.	Cloudless. Amorphous	57
,, 4.	Sunset.	Cloudbank	59 ?
,, 5.	Sunrise.	Cloudless. Amorphous	56
,, 5.	Sunset.	Slight cirrus	55
,, 6.	Sunrise.	A little scud	54
,, 6.	Sunset.	Apparent cirr. 15° above horizon	(75)
,, 6.	,,	Cirrus strips	54
,, 11.	Sunrise.	Slight detached scud	53
,, 11.	Sunset.	A little cirrus	66
,, 15.	Sunrise.	Cloudless	52 (?)
,, 17.	Sunset.	Striated haze film	56
,, 19.	,,	Cumulus clouds and bank	51
,, 23.	,,	Low cir-strat. &c.	61
Jan. 23.	,,	Clouds. White Mist	About 52
,, 28.	,,	Thin clouds on horizon	About 46
Feb. 2.	,,	Very low cloudbank	About 42

TABLE II.

Time at which the ulterior margin of Primary glow crossed the zenith on clear nights, in minutes from sunset or sunrise.

		Minutes.			Minutes.
Nov. 9.		37	Dec. 11.	Sunset	34
,, 28.		35	,, 23.	,,	39
Dec. 4.	Sunrise	36	Jan. 23.	,,	About 29
,, 4.	Sunset	34	,, 28.	,,	About 24
,, 5.	Sunrise	39	Feb. 2.	,,	About 21
,, 11.	,,	37			

TABLE III.

Time after sunset on clear evenings at which an unusual appearance was first observed in the western sky, such as a red sky glow, neglecting the green light above the sun.

	Minutes.		Minutes.
Nov. 9	12	Dec. 11	25
,, 10	14	,, 7	30
,, 25	11	,, 16	30
,, 27	15	,, 23	37
,, 28	25	Jan. 23	25
Dec. 4	19	,, 28	25
,, 5	25		

TABLE IV.

Time at which the last or first (that is the secondary) red glow in each case disappeared, or appeared, after sunset or before sunrise respectively.

Date.	Remarks.	Minutes.
Nov. 9.	Cloudless	100
,, 10.	Cloudless, but sky-glow very small	48
,, 25.	Hazy bank	45
,, 26.	Hazy, but clear sky	55
,, 27.	Clear	84
,, 28.	Slight cirrus	85
,, 30.	Sunrise. Clear, except little cir.-cum.	99
Dec. 1.	Sunset. Clear, except a few streaks	102
,, 4.	Sunrise. Clear	105
,, 4.	Sunset. Clear, except low clouds	72
,, 5.	Sunrise. Clear	106
,, 5.	Sunset, slight cirrus	80
,, 6.	Sunrise. Very clear and transparent	102
,, 9.	Sunset. Cloudy	81
,, 11.	,, Clear	104
,, 15.	,, Cloudy	101
,, 22.	Sunrise. Some clouds	104
,, 23.	Sunset. Cirro-strat. &c.	91
Jan. 24.	,,	About 80
,, 28.	,,	About 72

Time between appearance of primary and appearance of secondary glow on the horizon on the most favourable occasions.

At Sunrise. About 50 minutes.
At Sunset. ,, 38 ,,

Time after sunset at which the reflecting matter, at an altitude of about 45° above Western horizon, first became visible, and shone with reflected light.

	Minutes.
Dec. 21	35
,, 23	37

TABLE V.

Colour of spot or arc above the sun before sunrise and after sunset, from which the light was often strong enough to cast shadows, sometimes as long as forty minutes before sunrise, and thirty minutes or more after sunset.

Nov. 9.		Green, white and yellow
,, 24.		Yellowish green
,, 25.		Greenish white
,, 27.		Greenish white
,, 28.		Green
Dec. 2.	Cloudy	Amber
,, 4.	Sunrise	Greenish white
,, 4.	Sunset	Steely white

TABLE V.—*Continued.*

Colour of spot or arc above the sun before sunrise and after sunset, from which the light was often strong enough to cast shadows, sometimes as long as forty minutes before sunrise, and thirty minutes or more after sunset.

Dec. 5.	Sunrise	Olive green
„ 11.	„	Green
„ 11.	Sunset	Green
„ 12.	„ Cloudy	Yellowish green
„ 7.	„ Some cirrus	Greenish yellow
„ 15.	Sunrise	Green
„ 16.	Sunset. Scud clouds	Green
„ 19.	Sunrise	Green
„ 21.	Sunset	Green
„ 23.		Delicate green, turning greenish yellow.
Jan. 23.	Sunset	Bluish white
„ 24.	„	Greenish white
„ 28.	„	Bluish white

TABLE VI.

Giving the direction of the axis of the streaks on every day when observed.

Nov. 9.	Sunset	S to N ?
„ 10.	„	S to N
„ 23.	„	S to N
„ 24.	„	S to N
„ 25.	„	Amorphous
„ 26 & 27	„	Amorphous
„ 28.	„	Amorphous
„ 30.	Sunrise and Sunset	Amorphous
Dec. 1.	Sunset	Amorphous
„ 2.	„	Uncertain
„ 4.	Sunrise	WSW to ENE
„ 4.	Sunset	SW to NE
„ 5.	Sunrise	Ill-defined
„ 5.	Sunset	Uncertain
„ 7.	„	About S to N
„ 11.	Sunrise	S to N
„ 11.	1 p.m.	SSW to NNE
„ 11.	4.15 p.m.	SSW to NNE
„ 12.	3.45 p.m.	WSW by S to ENE by N
„ 15.	7.40 a.m.	SSW to NNE
„ 16.	11 to 12 a.m.	SW to NE and W to E
„ 16.	3.57 p.m.	SSW to NNE and WNW to ESE
„ 17.	Sunset	SSW to NNE
„ 19.	Sunrise	WSW to ENE
„ 19.	3.40 p.m.	SSW to NNE and W to E
„ 21.	4.22 p.m.	SSW to NNE, SW to NE and W to E
„ 23.	4.30 p.m.	Amorphous
Jan. 8.	(San Remo). Sunset	SW to NE
„ 9.	Sunrise	Do.
„ 9.	Sunset	SW by W to NE by E
„ 10.	Sunrise	SW by W to NE by E
„ 10.	Sunset	Ill-defined
„ 11.	Sunrise	SW by S to NE by N
„ 11.	Sunset	SW to NE and W to E
„ 13.	Sunrise	SSW by W to NNE by E
„ 13.	Sunset	Do. but some irregular cross streaks
„ 14.	Sunrise	SSW to NNE
„ 23.	Sunset	Irregular patches, chiefly about S to N
„ 24.	8.50 a.m. and till noon	SSW to NNE
„ 24.	3.30 p.m.	SSW to NNE
„ 28.	4.10 and 5.15 p.m.	SSE to NNW, short wavy billows
Feb. 2.	4.15, 4.45, to 5.5	WSW to ENE

The observations mentioned in the above paper were made at *Richmond, Surrey*, except where otherwise stated.

DISCUSSION.

Mr. DYASON remarked that, having given some attention to, and having attempted to represent some of the recent celestial phenomena in a series of coloured sketches—he had come to the following conclusions, quite independently of anything that had been written in the scientific periodicals, or that had been said in the Paper:—1. The Glows appeared upon an opalescence which covered the whole celestial arc; 2. Fore and Afterglows extended from the horizon to the zenith 90° and horizontal distance 90°; 3. The Foreglows and Afterglows preceded sunrise and succeeded sunset by about an hour; 4. The Foreglows were not so intense, but were of greater delicacy than the Afterglows; 5. From the zenith to the horizon the colours were lilac, pale pink, lemon and amber, in the Foreglows; 6. From the zenith, lilac, rose pink, amber and crimson in the Afterglows; 7. The Glows tended to prolong the light, and were not seen except in a dry atmosphere; 8. The Glows did not obscure the light of the moon, which appeared more or less green on a reddish or purplish background, according to the law of optics; 9. There was a decided break in time between the Foreglow and the sunrise, and between the sunset and the Afterglow; 10. The tints of these Glows were similar to those which played about the Snow-peaks and snow-fields of the Alps, preceding sunrise and after sunset as observed by himself when above the snow-line. There appeared to be nothing about the recent sunrises and sunsets other than a greater intensity in the primary colours and their compounds, arising from an abnormal clearness of the atmosphere. The Glows in Mr. Dyason's opinion were quite exceptional.

Prof. ARCHIBALD said, he had only seen one reference to a phenomenon which he had observed almost every day during the whole time the remarkable sunsets had been seen, viz. the presence of a halo throughout the day round the sun having a radius of about 22°, of a milky white colour in the interior, with a reddish brown fringe of about 5° or 6° in width. This constant phenomenon, apparently independent of all the varying conditions in the lower atmosphere, seemed to afford further proof to what had already been cited against the supposition that these remarkable sunsets were due to the presence in the atmosphere of a greater quantity of vapour than usual.

Mr. STANLEY remarked that he noticed in *La Nature* (February 9, p. 175), that similar sunsets were observed in 1831, after an eruption in Sicily, wherein a large column of dust was thrown into the air.

Mr. LADD stated that when passing through the Red Sea early in September last, he observed the sun after rising and before setting, and the moon before setting, to be green at an altitude of 20° to 25° above the horizon, and as low as could be seen. On the first occasion the green moon was covered with thin cirro-stratus over which the afterglow was cast, the sky immediately about the moon being yellow, and above orange and red. On other occasions both sun and moon appeared green, without any colouring of the sky, and so strong was the green light that the white paint about the ship was distinctly tinted by it. After passing out of the Red Sea no further peculiarity of appearance in the sky, sun or moon was noticed before reaching England in October. While observing for the rainband during this time, none could be seen, and the spectrum was very hazy, the Fraunhofer lines being very indistinct and sometimes invisible.

About the middle of December between Madeira and England he daily observed the extraordinary glows before sunrise and after sunset. They usually lasted from one and a half hour to two hours, and were generally very red, the sun as low as could be seen, which was about 10° above the horizon, being of a deep red, and the glows extending nearly to the zenith. During this time a gale of north-east wind was blowing accompanied by terrific hail and rain squalls, and the effect was very grand. The spectrum showed no rainband, and was extremely clear, the Fraunhofer lines being unusually well defined. Had he known what value was attached to any observations of this sort, and what was supposed to be the cause of these magnificent displays, he would have paid attention to details. He was in the Straits of Malacca at the time of the Java eruption and experienced no unusual occurrence except a fall in the barometer and a great rise in the thermometer. The summer in the China and Japan seas was extremely hot and oppressive.

It would seem as if, between his observations in September in the Red Sea and December in the North Atlantic, some cause was at work to produce the extraordinary and beautiful phenomena he saw, and that it was passing westwards.

Mr. SYMONS said that the volcanic eruptions in Iceland in the year 1783 were followed by results similar somewhat to those noticed recently, but the dust being thicker, the sun was more obscured than in 1883. The most remarkable fact about these recent phenomena, and one which to his mind was fatal to such an explanation as Mr. Dyason had given, was that from all parts of the world people had written saying that they had seen something they had never seen before. Such phenomena could hardly be ascribed to excess or otherwise of moisture in the atmosphere, as it was very unlikely that the same atmospheric conditions would prevail all over the world. At present he could only attribute the wonderful skies we had seen lately to the Krakatoa eruption, but he reserved full freedom to adopt any other explanation for which stronger evidence could be produced. He considered Mr. Russell's paper extremely valuable, as the descriptions of the phenomena were so accurate and minute.

Dr. TRIPE said that he did not agree with Mr. Dyason that the blue or green moon was generally seen with a red background, on the contrary, he had in all instances noticed a considerable space between the red or yellow sky and the moon. Whenever he had seen the moon green or blue, it was against a blue sky. He had also observed more than once the gas flame in the street lamps to have a green tint at the commencement of a red sunset.

Mr. RUSSELL in reply said that he had seen the halo or sheen around the sun referred to by Prof. Archibald during the last few days, but it was less distinct now than when he first observed it in the early part of December.

The PRESIDENT (Mr. Scott) remarked that Miss Ley in a letter to *Nature*, dated Dec. 3, which appeared p. 130, Vol. XXIX., was the first person who drew attention to the halo.

PROCEEDINGS AT THE MEETINGS OF THE SOCIETY.

JANUARY 16th, 1884.

Annual General Meeting.

JOHN KNOX LAUGHTON, M.A., F.R.A.S., F.R.G.S., President, in the Chair.

Mr. F. B. EDMONDS and Mr. E. J. C. SMITH were appointed Scrutineers of the Ballot for Officers and Council.

Dr. TRIPE read the Report of Council and the Balance Sheet for the past year p. 87.)

It was proposed by the PRESIDENT, seconded by Dr. TRIPE, and resolved :—"That the Report of the Council be received and adopted, and printed in the *Quarterly Journal* of the Society."

It was proposed by Prof. ARCHIBALD, seconded by Mr. ABERCROMBY, and resolved :—"That the best thanks of the Royal Meteorological Society be communicated to the Council of the Institution of Civil Engineers for having granted the Society permission to hold its Meetings in the rooms of the Institution."

It was proposed by Mr. ROSTRON, seconded by Captain TOYNBEE, and resolved :—"That the thanks of the Society be given to the Officers and other members of the Council for their services during the year."

It was proposed by Mr. INWARDS, seconded by Dr. MANN, and resolved :—"That the thanks of the Society be given to the Standing Committees and to the Auditors, and that the Committees be requested to continue their duties till the next Council Meeting."

The PRESIDENT then delivered his Address (p. 77).

It was proposed by Mr. SCOTT, seconded by Mr. LATHAM, and resolved:—
"That the thanks of the Society be given to the President for the ability and courtesy displayed by him in the Chair during the year, and for his Address, and that he be requested to allow it to be printed in the *Quarterly Journal* of the Society."

The Scrutineers declared the following gentlemen to be the Officers and Council for the ensuing year, viz.:—

President.

ROBERT HENRY SCOTT, M.A., F.R.S., F.G.S.

Vice-Presidents.

HON. RALPH ABERCROMBY.
EDMUND DOUGLAS ARCHIBALD, M.A.
JOHN KNOX LAUGHTON, M.A., F.R.A.S., F.R.G.S.
WILLIAM MARCET, M.D., F.R.S., F.C.S.

Treasurer.

HENRY PERIGAL, F.R.A.S.

Trustees.

HON. FRANCIS ALBERT ROLLO RUSSELL, M.A.
STEPHEN WILLIAM SILVER, F.R.G.S.

Secretaries.

GEORGE JAMES SYMONS, F.R.S.
JOHN WILLIAM TRIPE, M.D., M.R.C.P.Ed.

Foreign Secretary.

GEORGE MATHEWS WHIPPLE, B.Sc., F.R.A.S.

Council.

WILLIAM MORRIS BEAUFORT, F.R.A.S., F.R.G.S.
GEORGE CHATTERTON, M.A., M.Inst.C.E.
JOHN SANFORD DYASON, F.R.G.S.
WILLIAM ELLIS, F.R.A.S.
CHARLES HARDING.
RICHARD INWARDS, F.R.A.S.
BALDWIN LATHAM, M.Inst.C.E., F.G.S.
ROBERT JOHN LECKY, F.R.A.S.
EDWARD MAWLEY, F.R.H.S.
CUTHBERT EDGAR PEEK, M.A., F.R.G.S.
CAPT. HENRY TOYNBEE, F.R.A.S.
CHARLES THEODORE WILLIAMS, M.A., M.D., F.R.C.P.

Mr. LAUGHTON having left the Chair, it was taken by the newly elected President, Mr. SCOTT, who thanked the Fellows for the honour they had done him in electing him to that office.

FEBRUARY 20th, 1884.

Ordinary Meeting.

ROBERT H. SCOTT, M.A., F.R.S. President, in the Chair.

THOMAS GREEN BENN, Reigny House, Newton Reigny, Penrith;
CAPT. CHARLES FISHER COOKE, 5 Raymond Buildings, Gray's Inn, W.C.;
FRANCIS GALTON, M.A., F.R.S., 42 Rutland Gate, S.W.;
PROF. SAMUEL ALEXANDER HILL, Muir Central College, Allahabad;

CAPT. ARTHUR WELLESLEY JEFFERY, Underwood, Plympton, Devon ;
GEORGE PAUL, F.G.S., Moortown, Leeds ;
RICHARD VEEVERS, 15 Chapel Street, Preston ;
HENRY TITUS WAKEHAM, Oswestry ; and
EDWIN WELLS, Brunswick Cottage, Ashton-on-Mersey,
were balloted for and duly elected Fellows of the Society.

The following Papers were read, viz.:—

"THE GREAT STORM OF JANUARY 26th, 1884." By WILLIAM MARRIOTT, F.R.Met.Soc. (p. 114.)

"THE HEIGHT OF THE NEUTRAL PLANE OF PRESSURE, AND DEPTH OF MONSOON CURRENTS IN INDIA." By Prof. E. D. ARCHIBALD, M.A., F.R.Met.Soc. (p. 123.)

"ON THE SUNRISES AND SUNSETS OF NOVEMBER AND DECEMBER, 1883, AND JANUARY, 1884." By the Hon F. A. ROLLO RUSSELL, M.A., F.R.Met.Soc. (p. 139.)

CORRESPONDENCE AND NOTES.

OBSERVATIONS AT MEDIJIN SALIK, IN NORTH-WESTERN ARABIA. By E. M. DOUGHTY, F.R.G.S.

THE following observations were made at Medîjin Sâlik ['Εγρα Ptolemy], ruins of a caravan city of the antique gold and frankincense road (El Hejr) east from Greenwich 39° (nearly) ; north of the equator 26° 30′ ; inland from the Red Sea shore about 150 miles ; a valley plain, bottom 20 miles wide, enclosed by cliffs of sandstone upon the west side, the long Harra sandstone mountain (platform mean height 5,000 to 6,000 feet) covered with lava, and extinct volcanoes lying north and south thirty miles across.

1876. DECEMBER.

5th. 1.30 a.m. Barometer 26·97 ins. ; 11 a.m. 27·05 ins. ; 1.30 p.m. 27·01 ins. ; 7.30 p.m., 27·01 ins.
6th. 10 a.m. Thermometer 68° ; 5 p.m. Barometer 27·06 ins. ; 8 p.m. 27·05 ins.
7th. 8 a.m. 27·13 ins.
8th. 8 a.m. 27·21 ins. ; 1 p.m. 27·15 ins. ; 9 p.m. 27·17 ins.
9th. 8 a.m. 27·28 ins. ; 2.30 p.m. 27·17 ins. ; 5.30 p.m. 27·13 ins. ; 8.30 p.m. 27·09 ins.
10th. 8 a.m. 27·25 ins. ; 6 p.m. 27·05 ins. ; 9 p.m. 27·09 ins.
11th. 8.30 a.m. 27·18 ins. ; 5.30 p.m. 27·03 ins. ; 11 p.m. 27·12 ins.
12th. 8.30 a.m. 27·21 ins. ; 7 p.m. 27·12 ins.
13th. A moment before sunrise upon a stocking at the ground, 41° ; 8 a.m. 27·25 ins. ; 10 p.m. 27·17 ins.
14th. 8 a.m. 27·23 ins. ; on ground 45°·5 ; 8.30 p.m. 27·13 ins.
15th. 8.30 a.m. 27·17 ins. ; 8.30 p.m. 27·05 ins.
16th. 8 a.m. 27·22 ins. ; 8.30 a.m. thermometer on ground, 48°·7 ; 10 p.m. 27·05 ins.
17th. 10 a.m. 27·14 ins. ; 5 p.m. 27·02 ins. ; 8 p.m. 27·02 ins. ; on ground a moment before sunset, 41°·7.
18th. 11 a.m. 27·09 ins. ; 9.30 p.m. 26·97 ins. ; on the ground a moment before sunset, 42°·8.
19th. 8 a.m. Air and ground 44°·6 ; 8.30 a.m. 27·02 ins. ; 5.30 p.m. 26·89 ins. ; 9 p.m. 26·94 ins.
20th. 8 a.m. Ground, 50°·0, air 53°·6 ; 6 p.m. 27·00 ins. ; 9.30 p.m. 27·04 ins.
21st. 8 a.m. Air 32°·9, 27·05 ins. ; 6 p.m. 26·87 ins. ; 9 p.m. 26·93 ins.

22nd. 8 a.m. Ground 37°·4, 27·02 ins.; 1 p.m. wind; 3 ft. from ground, 62°·6; 6 p.m. 26·99 ins.; 10 p.m. 27·06 ins.
23rd. 8 a.m. 27·19 ins.; 7 p.m. 27·13 ins.; 10 p.m. 27·17 ins.
24th. 8 a.m. 27·23 ins.; 1 p.m. 27·17 ins.; 5.30 p.m. 27·10 ins.; 10.30 p.m. 27·13 ins.
25th. 8 a.m. 27·21 ins.
26th. 8.30 a.m. In shade, 44°·6; 9 p.m. 27·06 ins.
27th. 9 a.m. 27·13 ins.; 11.30 p.m. 27·05 ins.
28th. 8.30 a.m. 27·15 ins.

1877. January.

6th. 10 p.m. 27·22 ins.
7th. 8.30 a.m. 27·28 ins.; 9.30 p.m. 27.17 ins.
8th. 8.30 a.m. 27·19 ins.; 5.30 p.m. 27·02 ins.; 10.30 p.m. 27·03 ins.
9th. 8 a.m. Air 50°·9, 27·05 ins.; 5 p.m. 26·96 ins.; 9 p.m. 26·97 ins.
10th. 10 p.m. 27·02 ins. Day of rain from the afternoon.
11th. 8 a.m. 26·95 ins. 57°·2 after rain; 4 p.m. 26·86 ins., rain; 10 p.m. 26·89 ins., rain and thunder.
12th. 8 a.m. 48°·7, 26·95 ins.; 11 p.m. 27·05 ins., afternoon was showery.
13th. 8 a.m. 27·17 ins., return to-day of fair weather; 9 p.m. 27·25 ins.
14th. 8 a.m. 38°·5, 27·28 ins.; 6 p.m. 27·13 ins.; 10 p.m. 27·17 ins.
15th. 8 a.m. 40°·1, 27·15 ins.; 5 p.m. 27·02 ins.; 10 p.m. 27·08 ins.
16th. 8 a.m. 49°·1, 27·04 ins.; 10 p.m. 27·02 ins.
17th. 8 a.m. 50°·0, 27·10 ins.; 5 p.m. 26·99 ins.; 11·30 p.m. 27·06 ins.
18th. 8 a.m. 51°·8, 27·08 ins.; 2 p.m. in sun 92°·3, on the north side of a sandstone mountain shadow, 65°·3.
19th. 8 a.m. 27·02 ins.; 9.30 p.m. 26·99 ins.
20th. 8 a.m. 27·00 ins.; 9·30 p.m. 26·91 ins.
21st. 8.30 a.m. 26·95 ins., lowering weather; 5.30 p.m. 26·85 ins.; 11 p.m. 26·92 ins.
22nd. 11 a.m. 27·01 ins., rain falling; 5 p.m. 26·89 ins., rain; 10 p.m. 26·95 ins.
23rd. 9 a.m. 27·06 ins.; 10 p.m. 27·01 ins.
24th. 9 a.m. 26·99 ins.; 10 p.m. 26·85 ins.
25th. 8 a.m. 26·80 ins., raining over the mountains; 1 p.m. 26·73 ins.; 5 p.m. 26·75 ins.; 10 p.m. 26·75 ins.
26th. 8.30 a.m. 26·89 ins.; 11 p.m. 26·95 ins.
27th. 8.30 a.m. 50°·0; 9.30 a.m. 27·05 ins.; 11 p.m. 27·05 ins.
28th. 9 a.m. 27·14 ins.; 11 p.m. 27·05 ins.
29th. 8.30 a.m. 27·09 ins.; 11 p.m. 26·83 ins.
30th. 8.30 a.m. 26·88 ins.; 10 p m. 26·82 ins.; day of rain.
31st. 8 30 a.m. 26·75 ins.; 11 p.m. 26·83 ins.

1877. February.

1st. 1 p.m. 27·01 ins., strong wind; 10.30 p.m. 27·09 ins., wind fallen.
2nd. 8.30 a.m. 27·16 ins., misty over the mountains.
3rd. 8 30 a.m. 27·01 ins., misty; 10.30 p.m. 26·91 ins.
4th. A moment before sunrise 39°·2; 8 a.m. 26·95 ins.; 11 p.m. 26·91 ins.
5th. 7.30 a.m. 26·95 ins.; 10.30 p.m. 27·00 ins.
6th. 11 p.m. 27·01 ins.
7th. 12 p.m. 26·91 ins.
8th. 9 p.m. 26·97 ins.
9th. 11 p.m. 27·05 ins.
10th. 12 p.m. 27·09 ins.
11th. 11.30 p.m. 27·10 ins.

1877. May.

6th. 10 a.m. in stone (?) room, 85°·1. Barley and wheat harvest in a close valley 300 ft. lower was in the first days of April.
8th. Noon in stone room, 87°·8.
9th. At sunset, in stone room, 88°·7.

1877. August.

10th. Sunrise, 75°·2. Noon, shadow of mountain rock, 88°·7, then 92°·3.

11th. 1 p.m. Shadow of a black worsted tent, open to the ground heat, 99°·5.

12th. Sunrise, 83°·3; evening, vapour rising from the enclosed plain, obscured the lesser stars and meteors.

17th. 4 p.m. heavy, sky overcast. 104°·9, tent shadow.

18th. 3 p.m. 106°·7, tent shadow.

20th. 4.30 p.m. 104°·9, tent shadow.

21st. Sunrise 71°·6; 1 p.m. 105°·8, tent shadow.

22nd. Sunrise, water hung in sweating skins, 51°·8; air 66°·2.

1878. April.

23rd. Triple rainbow seen spanning all the eastern sky, the sun near its setting breaking forth after stormy afternoon showers. Central steppes of Archi, district El-Ghraymar, about 43° east from Greenwich, and about 27° north from the Equator. Chain lightning seen the same evening.

Aneroid by Trocken, compared with standard barometer at Beyrout, 1876, before my travels, showed a very small error in the oscillations. At the end ot my travels, 1879, when I was robbed, it was snatched from my neck and received a shock, but nevertheless it has gone apparently well since.

On December 11th, 1883, the aneroid was compared with the standard barometer at the Meteorological Office, and found to read correctly. The observations made with it give the following results, but the times are only approximate:—

Month.	Hour.	Means.	Number of Observations.
		Ins.	
1876 December.	8 a.m.	27·142	24
,,	6 p.m.	27·040[1]	11
,,	9 p.m.	27·063[1]	19
1877 January.	8 a.m.	27·040	26
,,	10 p.m.	27·087	25
February.	10 p.m.	27·993	9

[1] These means are obtained by differences from the 8 a.m. observations.

On the Rainfall and Temperature of Markree, Sligo. By William Doberck, Ph.D., F.R.Met.Soc., M.R.I.A., Director of the Hong Kong Observatory.

Table I. shows the quantity in inches of rain collected at the Markree Observatory, near Sligo, Ireland (lat. 54° 11′ N., long. 8° 27′ W.), during the years 1833-1863, both inclusive.

The gauge, which is square (area one square yard), is placed on top of the library, 16¼ ft. above ground and 148 ft. above mean sea level. At the end of 1874 I placed an ordinary gauge of 5 ins. diameter in a convenient situation, 6 ins. above ground and 110 feet above sea. From a comparison of the amount of rain collected in these two gauges during seven years—1875-1881 inclusive—it follows that the amount registered by aid of the upper gauge must be multiplied by 1·2045 in order to reduce it to the level of the lower gauge. The monthly totals (1833-63) thus reduced are as follows:—Jan. 4·156 ins., Feb. 3·337 ins., March 2·993 ins., April 2·963 ins., May 2·440 ins., June 3·666 ins., July 3·955 ins., Aug. 4.335 ins., Sept. 3·913 ins., Oct. 4·674 ins., Nov. 4·252 ins., Dec. 4·184 ins. The reduced total annual rainfall is 44·87 ins.

Table II. exhibits the mean monthly temperature at Markree from 1842 to 1863, both inclusive, as obtained by taking the mean of the maximum and minimum

registered. The thermometers were read at 8 a.m. up to the 30th of June 1846, and at 10 a.m. subsequently. The correction required for reducing the results thus obtained to the mean of the twenty-four hourly readings could be derived with perhaps sufficient accuracy from the registers kept for the last fifteen years at Armagh and Valencia.

Whenever a monthly value is wanting in Table II. the general mean of that month has been used in calculating the annual value.

Table III. exhibits the maximum temperature registered in any month.

Table IV. exhibits the minimum temperature registered in every month.

The highest mean maximum, 77°·6, occurs in June; the maximum mean temperature, 59°·2, in July. The lowest mean minimum, 23°·4, in February; the minimum mean temperature, 39°·4, in January: but the thermometers being hung against the wall of the observatory, it follows that extreme air temperatures are not correctly registered, though the average temperatures are not influenced thereby. Night frosts are rare in May and September, and do not occur in June, July and August; but of course this refers to the atmosphere at some distance from the ground. The maximum monthly rainfall (in October) corresponds nearly to the epoch of the minimum range of temperature (in November); the minimum rainfall (in May) to the maximum range of temperature (same month). The registers were unfortunately discontinued after 1863.

The calculations were made partly by my predecessor at Markree Observatory and partly by Miss Doberck, who has succeeded in discovering and correcting a number of errors in the registers.

TABLE I.—RAINFALL.

Year.	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.
1833	1·416	5·586	1·230	3·070	1·660	4·345	2·500	1·340	5·705	4·670	6·022	6·945	44·489
34	4·478	4·085	1·917	0·361	2·392	5·053	4·371	2·550	2·990	2·918	3·214	2·166	36·495
35	3·112	6·067	2·772	1·093	3·280	1·902	2·905	3·045	4·300	3·398	4·178	1·285	37·337
36	3·981	1·965	3·940	2·225	0·240	2·853	4·731	1·643	4·959	3·530	5·865	5·456	41·388
37	2·455	4·310	2·080	3·900	2·233	1·912	2·773	3·450	4·385	4·097	5·484	3·213	40·292
38	0·897	1·233	3·022	3·367	0·477	1·418	3·233	3·771	2·284	3·156	4·326	3·812	30·996
39	3·606	2·707	2·853	2·235	0·908	2·783	2·030	3·250	5·498	2·600	3·625	1·825	33·920
1840	4·300	2·405	0·375	0·972	2·613	2·380	3·259	3·925	3·969	2·356	2·350	1·870	30·774
41	2·375	1·380	2·337	2·325	1·730	2·410	3·880	4·355	2·645	4·509	3·225	4·375	35·546
42	2·862	2·488	2·548	1·237	3·706	2·866	2·506	1·621	2·846	4·254	3·600	2·712	33·246
43	3·633	0·940	0·938	3·335	2·567	2·212	4·661	3·763	1·492	6·218	3·973	2·232	35·964
44	2·772	4·770	2·505	1·792	0·139	3·779	3·684	3·453	2·427	6·542	1·346	0·424	33·633
45	4·346	3·145	1·390	2·028	1·423	3·673	4·128	2·493	3·032	3·557	5·314	5·838	40·367
46	4·243	2·403	4·070	3·845	1·828	1·770	3·009	4·788	1·985	4·240	2·816	2·560	37·557
47	2·789	2·469	0·694	3·723	3·594	1·693	1·632	2·966	3·784	3·876	4·432	5·515	37·167
48	3·061	5·123	4·247	2·005	2·013	3·771	3·416	4·484	2·269	4·398	3·372	3·058	41·217
49	3·617	1·897	1·276	4·321	1·931	0·701	3·925	3·814	3·385	5·175	4·845	2·740	37·627
1850	2·367	4·280	1·754	3·467	2·335	2·723	2·586	4·668	2·342	3·212	4·385	2·999	37·118
51	5·010	2·890	3·069	2·232	1·530	4·802	3·016	5·696	1·956	4·647	3·340	2·065	40·253
52	6·070	4·320	0·729	1·061	1·337	5·475	3·335	5·201	2·148	4·001	4·662	7·380	45·719
53	6·134	1·509	3·836	2·957	0·656	2·896	3·836	2·544	2·579	4·509	2·310	1·401	35·167
54	3·794	2·081	1·872	0·914	3·434	2·950	3·121	1·642	2·661	3·621	3·657	5·018	34·765
55	0·596	1·358	2·359	1·682	2·275	2·952	4·072	3·917	1·415	3·909	1·128	3·698	29·361
56	2·397	2·116	0·760	0·735	2·852	2·221	3·453	3·474	2·330	1·611	2·463	3·460	27·872
57	4·035	2·084	2·118	5·420	0·885	4·361	2·037	1·661	4·037	2·809	2·555	3·136	35·138
58	2·271	2·096	2·494	3·965	2·717	2·190	2·960	3·126	2·285	3·604	1·245	5·391	34·344
59	4·357	2·161	4·822	3·748	0·545	2·055	4·548	4·130	5·093	2·817	2·839	4·536	41·651
1860	5·011	2·826	4·128	1·938	5·201	6·199	2·479	6·875	1·376	3·766	2·373	1·566	43·738
61	2·599	1·995	5·072	0·430	1·770	4·236	5·684	6·487	6·424	3·286	5·862	2·680	46·525
62	4·605	0·916	3·335	3·250	2·162	2·635	3·642	2·860	2·617	6·438	3·059	4·708	40·227
63	3·792	2·291	2·483	2·625	2·390	3·133	0·395	4·576	5·500	2·602	1·550	3·634	34·971
Mean	3·451	2·771	2·485	2·460	2·026	3·044	3·284	3·599	3·249	3·881	3·530	3·474	37·254

TABLE II.—MEAN TEMPERATURE.

Year.	Jan.	Feb.	March.	April.	May.	June.	July.	August.	Sept.	Oct.	Nov.	Dec.	Mean.
	°	°	°	°	°	°	°	°	°	°	°	°	°
1842	37·3	40·0	44·5	49·1	50·9	60·5	57·7	58·7	54·4	45·4	41·0	..	48·4
43	43·5	36·8	42·7	..	45·5	57·0	58·3	59·8	57·8	46·8	43·6	47·0	48·8
44	40·4	36·1	41·3	48·1	54·2	54·4	57·6	55·8	54·6	47·0	43·2	35·6	47·4
45	37·8	39·1	38·6	48·1	51·2	56·0	56·7	54·6	51·9	47·9	42·0	38·6	46·9
46	43·1	41·6	39·9	44·3	50·3	61·9	..	..	..	..	..	..	..
47	..	38·4	42·8	43·9	52·9	54·7	61·8	55·6	49·9	47·3	44·5	39·8	47·6
48	34·1	42·4	40·1	44·5	56·2	56·5	59·5	55·2	52·6	47·2	42·5	40·5	47·6
49	39·7	42·9	44·1	43·9	53·6	53·4	59·5	59·6	55·2	45·6	44·9	37·1	48·3
1850	36·9	44·4	43·1	48·3	51·1	58·8	58·9	57·8	53·7	48·3	38·8	44·5	48·7
51	40·5	42·0	42·7	45·9	52·1	59·1	59·2	60·8	56·6	51·2	42·6	42·6	49·6
52	40·9	42·1	43·2	49·0	52·9	56·6	63·0	59·3	54·5	47·9	42·6	43·2	49·6
53	39·5	37·7	40·7	46·2	51·8	56·8	57·7	57·8	53·3	48·3	42·2	37·7	47·5
54	37·5	40·2	44·5	49·0	48·8	54·4	56·8	58·5	56·3	48·2	42·7	42·6	48·3
55	36·4	30·8	38·6	45·5	48·0	55·3	61·7	59·2	54·2	47·5	40·6	38·3	46·3
56	36·0	40·4	40·2	45·9	49·0	55·8	59·2	63·6	54·6	52·0	45·4	41·7	48·6
57	39·3	41·6	42·2	46·9	54·1	62·7	61·5	62·1	58·5	51·5	45·2	46·7	51·0
58	43·4	39·6	44·6	47·7	50·5	59·3	57·0	59·1	57·5	47·7	40·6	44·0	49·2
59	41·4	42·5	45·7	45·5	53·6	60·2	64·0	60·0	53·9	48·1	43·5	35·5	49·5
1860	38·3	38·3	41·6	44·7	54·3	55·5	59·1	56·0	51·9	49·5	41·5	35·7	47·2
61	40·3	41·1	43·1	49·6	53·2	61·0	58·5	59·0	55·3	49·9	39·4	40·2	49·3
62	40·7	42·0	42·2	48·2	53·6	55·3	56·2	57·9	56·2	49·0	38·5	44·1	48·7
63	39·6	42·7	44·9	46·0	50·3	56·3	59·6	57·2	51·8	44·0	45·2	43·1	48·4
Mean	39·4	40·1	42·3	46·7	51·7	57·3	59·2	58·5	54·5	48·1	42·4	40·9	48·5

TABLE III.—MAXIMUM TEMPERATURE.

Year.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Highest.
	°	°	°	°	°	°	°	°	°	°	°	°	°
1842	48·2	51·5	55·0	70·1	74·2	83·8	76·4	73·8	69·8	60·7	50·7	..	83·8
43	53·3	53·2	53·4	..	68·0	78·6	69·7	79·4	76·4	68·4	55·7	56·2	79·4
44	56·4	49·9	55·0	65·4	77·4	67·5	75·2	74·9	75·5	58·0	55·1	47·9	77·4
45	54·2	52·4	55·7	68·2	69·7	72·2	80·0	71·3	68·8	62·3	52·6	53·7	80·0
46	54·7	54·8	54·3	58·3	81·0	86·9	..	..	..	..	..	..	86·9
47	..	52·1	56·5	58·4	73·1	80·5	83·4	72·2	61·5	61·2	55·7	54·0	83·4
48	47·1	54·8	54·0	57·9	76·0	75·7	77·7	69·0	70·1	64·3	53·0	54·0	77·7
49	51·9	53·0	56·5	63·1	78·3	75·0	83·5	75·9	70·9	59·0	55·2	50·2	83·5
1850	50·7	54·8	56·9	60·6	84·8	75·1	83·8	72·5	67·6	59·3	58·6	60·2	84·8
51	57·0	53·2	54·0	59·4	80·2	92·0	84·7	74·0	71·0	62·4	53·3	55·7	92·0
52	52·0	53·0	60·8	68·3	72·2	70·0	77·9	72·7	71·7	59·2	57·4	54·0	77·9
53	51·7	49·5	54·0	57·7	70·0	74·8	71·2	72·1	66·3	59·9	56·5	52·7	74·8
54	54·0	52·5	55·7	66·0	64·5	68·9	70 6	73·7	74·7	61·7	57·7	55·7	74·7
55	52·2	47·1	52·2	65·1	68·7	77·7	76·2	76·2	66·2	64·3	55·7	49·8	77·7
56	49·1	53·7	55·8	62·8	67·2	79·0	76·6	86·0	66·9	64·5	56·1	55·7	86·0
57	53·0	53·7	53·6	58·8	75·3	84·6	74·9	82·2	73·2	67·1	58·0	55·5	84·6
58	52·8	54·0	60·2	71·8	67·0	82·7	75·0	80·2	72·8	64·3	55·1	54·4	82·7
59	53·4	56·1	56·4	68·3	74·0	79·1	79·5	77·9	66·7	68·2	55·7	50·0	79·5
1860	52·8	51·2	54·1	65·3	73·2	76·4	82·0	68·2	69·3	62·0	57·4	51·1	82·0
61	54 3	55·9	54·7	70·0	73·3	81·7	69·8	69·2	67·4	60·9	54·6	54·4	81·7
62	53·0	54·1	56·3	65·3	68·1	72·5	69·7	70·5	70·8	65·0	55·8	53·0	72·5
63	53·0	53·9	60·3	60·2	70·0	72·8	76·3	76·3	69·1	55·1	55·8	55·2	76·3
Mean.	52·6	52·9	55·7	63·9	73·0	77·6	76·9	74·7	69·8	62·3	55·5	53·8	..
Highest.	57·0	56·1	60·8	71·8	84·8	92·0	84·7	86·0	76·4	68·4	58·6	60·2	92·0

TABLE IV.—MINIMUM TEMPERATURE.

Year.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sep.	Oct.	Nov.	Dec.	Lowest.
	°	°	°	°	°	°	°	°	°	°	°	°	°
1842	24·2	29·5	30·0	30·9	35·8	42·3	44·6	44·2	35·6	30·0	30·9	30·7	24·2
43	28·9	19·7	24·5	30·7	34·4	40·0	47·8	44·6	38·0	27·0	26·5	35·0	19·7
44	25·0	26·0	27·4	35·0	33·0	44·7	43·3	45·5	35·5	33·6	33·6	24·5	24·5
45	25·8	27·8	21·0	32·0	34·8	42·4	42·0	42·2	37·5	34·9	26·0	26·2	21·0
46	31·0	26·7	12·1	27·5	36·3	42·0	36·3	37·0	29·5	31·6	25·2	20·0	12·1
47	29·8	11·5	24·0	28·2	31·2	36·3	39·9	40·9	37·4	33·3	28·6	25·4	11·5
48	18·0	26·9	30·1	29·5	36·7	42·0	45·5	42·0	38·0	24·2	30·6	25·4	18·0
49	23·0	26·8	27·2	30·0	36·0	38·2	42·6	44·4	38·0	26·7	32·1	19·4	19·4
1850	17·6	28·6	24·0	33·2	30·1	41·6	45·3	37·7	36·9	31·7	24·5	26·4	17·6
51	26·0	25·2	27·6	30·4	33·8	36·2	44·7	46·2	40·5	36·5	24·4	27·4	24·4
52	23·5	26·6	28·7	30·5	37·2	40·2	44·3	45·7	33·0	33·3	26·7	30·0	23·5
53	24·2	21·0	23·2	30·0	32·7	35·9	42·0	41·7	34·5	28·0	24·8	24·3	21·0
54	13·2	24·9	27·9	28·0	30·6	39·3	40·9	42·6	37·0	28·3	23·2	28·0	13·2
55	17·0	7·2	21·8	28·3	25·3	37·2	44·6	44·7	32·0	25·7	23·2	17·8	7·2
56	14·7	15·2	20·3	26·9	26·8	37·9	40·7	47·7	38·5	31·2	27·4	20·0	14·7
57	21·0	27·3	25·7	31·2	34·9	43·0	43·3	43·0	39·0	32·6	24·9	33·0	21·0
58	30·0	22·3	24·0	32·0	31·2	38·7	40·2	39·7	37·0	29·8	21·9	29·0	21·9
59	30·4	26·8	27·5	26·0	31·8	40·8	45·7	41·5	37·0	25·3	26·9	9·2	9·2
1860	26·0	21·0	26·0	27·9	30·9	42·0	41·6	43·2	33·0	30·5	24·1	11·5	11·5
61	25·2	20·5	30·8	31·5	29·5	40·0	43·0	47·0	40·5	31·0	25·0	23·2	20·5
62	21·2	25·0	19·0	29·1	37·4	40·9	42·0	41·4	38·0	32·5	28·2	32·1	19·0
63	25·5	28·8	27·1	31·0	34·2	38·8	42·0	37·2	36·2	32·0	30·2	29·8	25·5
Mean.	23·7	23·4	25·0	30·0	32·9	40·0	42·8	42·7	36·5	30·4	26·8	24·9	..
Lowest.	13·2	7·2	12·1	26·0	25·3	35·9	36·3	37·0	29·5	24·2	21·9	9·2	7·2

METEOROLOGY OF CAPE HORN.

Paris Academy of Sciences has just published the Report of the Scientific pedition which was sent to Cape Horn to take magnetical and meteorological ervations during 1882-83, in conjunction with the International Polar Expedi- s from other countries.[1] The following particulars are extracted from the ort of Lieut. J. Lephay, who had charge of the meteorological observations.

he climate of the country south of the Straits of Magellan may be considered livided into two distinct regions. The first, to the west of the chain of ntains, culminating in the Sarmiento and the Darwin, includes the whole of North-eastern part of Tierra del Fuego, and the second includes the sides of Beagle canal in the East of the Murray Straits.

ccording to observations made by English missionaries residing as far as limits of the Western portion of the first region, the climate is decidedly less stant and the atmosphere less damp than in the second region, where it ssentially "maritime" and "neutral," without well marked seasons. That ion with which the expedition was more particularly concerned includes ste Island, Nassau Bay, Cape Horn's Archipelago, the coasts and Western nds of Tierra del Fuego.

unny days are rare with a gray sky, and the aspect of the country is dismal l cheerless.

There is a continued fall of water winter and summer, either under the form rain, hail, snow, or ice crystals, there being a mean of twenty-five rainy days each month, including at least seven or eight of hail or snow.

In such a climate there is hardly any difference of seasons, the temperature is intained nearly uninterruptedly at a degree similar to that of the Scotch and rwegian Seas throughout the months of October and November.

[1] *Mission Scientifique du Cap Horn*, 1882-83. *Rapports Préliminaires*, *Paris*, 1884. 80 pp. 4to.

During the winter there were 115 hours of gales, and in summer 296; showing the winter to be relatively calm. Westerly winds prevail the whole year, or rather those included between West, North-west, and South-west; their mean velocity is also much higher than that of the winds from the other quarters. Gales are well known to be very common at Cape Horn, the wind being nearly always from the North-west or West-north-west, ending between the West-south-west and South-south-west; three gales were recorded from North-north-east and North. The gales are very sudden.

The mean barometric pressure for the year, at an altitude of 39 ft., was 29·37 ins. The highest reading was 30·16 ins. at noon on May 1st; and the lowest 28·40 ins. at 4 a.m. on February 26th. During the sojourn of the expedition 140 depressions passed over Orange Bay; the average duration of each depression being 59 hours.

The mean temperature for the year was 42°·0; the mean for the summer being 44°·9, and the winter 38°·4. The highest temperature, 76°·1, was registered at 11 a.m. on February 20th; and the lowest, 18°·8, at 2.45 p.m. on August 7th. The mean daily maximum temperature, 49°·2, occurred about 12.55 p.m.; and the mean daily minimum, 36°·1, about 2.5 a.m. There were 73 frosty days and 346 frosty hours, of which 34 occurred in the summer. The mean relative humidity for the year was 82·1 per cent.; the lowest observed was 38 per cent. The total rainfall was 52·5 ins. Snow fell on 70 days, 24 of which were in summer. Rain fell during 1,599 hours, distributed over 278 rainy days. The sun shone during 855 hours: in June there were only 28 hours' sunshine. The average velocity of the wind was 23·77 kilometres per hour. The greatest velocity of the wind occurred during a gale on the afternoon of March 6th, when it exceeded 39 metres per second.

The mean temperature of soft and salt water at the surface was 42°·8 and 45°·6 respectively. The normal electrical tension was positive, and strongest with a clear sky and frosty weather than under any other conditions. On about ten different occasions sparks were observed on the cap of the electrometer. During the fall of hail, the needle was invariably deflected to the extreme negative limit of the scale; snow producing a contrary effect. With rain the electricity was negative.

From the experiments of MM. A. Müntz and E. Aubin it is shown that the amount of carbonic acid in the air at Cape Horn is decidedly less than that observed in Europe, as only 2·56 parts in 10,000 were found on the expedition station. These results agree with those obtained by Mons. Fleuriais in Patagonia and Mons. de Bernardières in Chili. The mean results were for the night (17 determinations) 2·556, and for the day (21 determinations) 2·563, showing that at Orange Bay the carbonic acid does not increase at night, which is the reverse of what is usually found. Similar results were obtained in Patagonia. The apparent cause of this phenomenon is the scarcity of vegetable life, while the enormous extent of sea area round Cape Horn probably accounts for the small amount of carbonic acid contained in its atmosphere.

RECENT PUBLICATIONS.

Annalen der Hydrographie. XI Jahrgang, 1883. Heft XI. 4to.

Contains:—Die täglichen Aenderungen der Windstärke über dem Lande und dem Meere, von Dr. W. Köppen (18 pp.).—Ueber einige meteorologische und oceanographische Ergebnisse der österreichischen Nordpolar-Beobachtungsstation auf Jan. Mayen 1882-1883.—Ueber den Einfluss der Temperaturvertheilung auf die oberen Luftströmungen und auf die Fortpflanzung der barometrischen Minima, von Dr. W. Köppen (9 pp.).

Annuaire de la Société Météorologique de France. Vol. XXX., November 1882, and Vol. XXXI., October 1883. 4to.

Contains:—Note sur le régime des vents à Lorient, par M. Louvet (4 pp.).—Note sur un secousse de tremblement de terre, observée à la Rochelle et dans le

département de la Charente-Inférieure le 26 juillet 1882, et sur des élévations anormales de la marée dans le port de la Rochelle, par M. A. Vivier (3 pp.). This earthquake was felt on the 26th July, 1882, at 3.38 p.m., and was attended with a rumbling noise and vibrations; the phenomenon was much more strongly marked in other parts of that same department.—Note sur un raz-de-marée observé à la Rochelle, le 22 Avril, 1882, par M. A. Rubino (1 p.). At 7.30 a.m. the South wind suddenly veered to the West raising clouds of dust, at the same time an enormous wave broke into the harbour, while the water-level rose by nearly 3·94 ft. in two minutes; fifty seconds later it had resumed its usual height. A similar alteration in the water-level of the harbour, although in a lesser degree, was repeated on four occasions, the last occurring at 8.40 a.m.—Epoque des maxima de la température dans les différentes parties du globe, par M. E. Renou. (2 pp.). It is known that in the temperate zone of the Northern Hemisphere the maximum temperature occurs usually at the end of July. In the corresponding zone the other side of the equator the maximum temperature is met with in January. Between the two, as on the equator, this period varies, depending on the storms so frequent in that region. M. Renou concludes that a great analogy exists between the succession of the maxima periods in the two continents; these periods progress from July to January and from January to July, following a direction from north to south on the eastern side of the continents and returning by their western side.—Manuel de la prévision du temps à Bar-le-Duc (4e partie), par M. Poincaré (36 pp.).—Résumé des observations centralisées par le service hydrométrique du bassin de la Seine pendant l'année 1882, par M. Goupil (38 pp.). This paper contains an interesting table showing the mean monthly and yearly rainfall in the basin of the Seine, this rainfall appearing to vary in a great measure with altitude above the sea. The following is an abstract of the present table:—

Station.	Department.	Altitude. ft.	No. of Years.	Annual Rainfall. ins.
Les Settons, près Montsauche	Nièvre	1955	22	69·29
Pannetière, près Montreuillon.	Nièvre	906	22	35·63
Châtillon-sur-Seine.	Côte d'or	738	20	30·39
Vassy.	Haute Marne	600	16	34·76
Sommesous.	Marne	577	17	27·68
Paris (la Villette, Buttes-Chaumont).	Seine	177	22	23·47
Rouen.	Seine Inférieure	20	17	27·88

Bollettino Mensuale pubblicato per cura dell' Osservatorio Centrale del Real Collegio Carlo Alberto in Moncalieri. Serie II. Vol. II. Nos. X.-XI. October-December 1883. 4to.

Contains amongst numerous articles the following:—Sopra la determinazione della Rugiada, by Prof. L. O. Ferrero (4 pp.). Recognising the importance in agriculture of dew measurement and its neglect by meteorologists, the author has designed an instrument (Drosometer) for its collection, employing fustian cloth for the depositing surface, as a material most closely corresponding to vegetable growth in texture. Discussing the results obtained by this means, he finds that the amount of water deposited as dew on his apparatus during the summer months averaged about 130 grammes per square mètre per night.—Nefoscopio, by P. F. Cecchi (5 pp.). The author describes several forms of the instrument, and suggests various methods for using it.

Ciel et Terre, Revue populaire d'Astronomie, de Météorologie, et de Physique du Globe. Vol. IV., No. 23.—Vol. V., No. 4. February to April 1884. 8vo.

The principal meteorological contents are:—Les lueurs crépusculaires, par A. Lancaster (15 pp.). The coloration of the sky after sunset, as seen from the Puy-de-Dôme, was remarkable during the winter 1879-80 and 1881-82, especially the latter, which was marked by an excessive degree of dryness. When the atmospheric moisture is at a very great altitude, while the lower strata remain

very clear, twilight may last a considerable time. In the summer of 1831 twilights of considerable duration were observed from Madrid to Odessa, they were especially remarkable on the 24th, 25th, and 26th September. On the 25th, shortly after sunset, the sky assumed a deep orange tint, then a red colour, while the lighted portion of the sky was lessening in area. A light spot remained at 8 o'clock corresponding to the position of the sun, which was 19° 30′ below the horizon; similar phenomena were observed on other days. The author does not believe in the coloration of the sky produced by volcanic action.—L'hiver de 1883-1884, par A. Lancaster (5 pp.).—Les dépressions atmosphériques et les phénomènes météorologiques (8 pp.).—Les Orages (3 pp.).—Le paratonnerre Melsens, par L. Mahillon (9 pp.). The main characters of this system of lightning conductor are a large number of points, a considerable multiplication of the conductors, and their communication as perfectly as possible with the ground.—Le gradient barométrique (4 pp.).

INDIAN METEOROLOGICAL MEMOIRS, being occasional Discussions and Compilations of Meteorological Data relating to India and the neighbouring Countries. Published under the direction of HENRY F. BLANFORD, F.R.S., Meteorological Reporter to the Government of India. Vol. II. Part II. 4to. 1883.

Contains:—Note on Mr. Chambers' List of Cyclones, and on the Gujarat Land Cyclone of July 11th-13th, 1881, by H. F. Blanford, F.R.S. (23 pp. and 4 plates).—On the Temperature of North-Western India, by S. A. Hill, B.Sc. (45 pp. and 5 plates). The author has collected and discussed all the temperature observations available, and from these he has prepared isothermal charts for each month and for the year.

JOURNAL OF THE ASIATIC SOCIETY OF BENGAL. Vol. LII. Part II. 1883. 8vo.

Contains:—On the measurement of solar radiation by means of the black-bulb thermometer *in vacuo*, by S. A. Hill (4 pp.). This consists of a discussion of the observations of the solar thermometer made at the Allahabad Observatory during the years 1876-1882. The author points out that, taking as the fundamental datum, the difference of the solar thermometer reading and that of the maximum shaded thermometer, the values would be affected by—1st, the thickness of the atmosphere traversed; 2nd, the absorptive power of the transparent atmosphere, which chiefly depends on the water vapour present; 3rd, the haze and dust; 4th, the radiating and reflecting powers of the ground; 5th, the variable difference of the temperature at the time of the maximum insolation and that shown by the shaded maximum thermometer; all of which must be allowed for before any conclusion could be drawn as to the solar radiation intensity.

METEOROLOGISCHE ZEITSCHRIFT. Herausgegeben von der DEUTSCHEN METEOROLOGISCHEN GESELLSCHAFT. Redigirt von Dr. W. KÖPPEN. 1884, January. 4to.

This periodical is the organ of the newly established German Meteorological Society, which was founded at Hamburg on November 17th, 1883, and to which various filial Societies have already associated themselves. The principal papers in this No. are:—Bericht über die vulkanischen Ausbrüche des Jahres 1883 in ihrer Wirkung auf die Atmosphäre, von Dr. Neumayer (4 pp.).—Die photographische Beobachtung der Wolken, von Dr. W. Zenger (7 pp.).—Die Verteilung des Luftdrucks über Mittel-Europa im Juni, von Dr. Krankenhagen (4 pp.).—Die tägliche Periode der Richtung des Windes, von Dr. A. Sprung (7 pp.).—Die Untersuchungen von Hoffmeyer und Teisserenc de Bort über Wintertypen und der Winter 1883-84, von Dr. J. van Bebber (7 pp.).

MITTEILUNGEN DES VEREINS FÜR ERDKUNDE 1883. 8vo. 1884.

Contains:—Die Ergebnisse der meteorologischen Beobachtungen der Herren Herm. Soyaux und Kapt. R. Mahnke in Ssibange-Farm am Awandu, Gabun, Westafrika, während der Jahre 1882 und 1883, sowie Bermerkungen zu den meteorologischen Beobachtungen aus Omaruro im Damaralande, von Dr. A. von Danckelman (14 pp.).

Proceedings of the Royal Society. Vol. XXXVI. No. 229. 1884. 8vo.

Contains:—Note on a Series of Barometrical Disturbances which passed over Europe between the 27th and the 31st of August, 1883, by Robert H. Scott, F.R.S. (5 pp. and plate).—Note on the foregoing Paper, by Lieut.-Gen. R. Strachey, F.R.S. (8 pp.). The correspondence of the forms and times of occurrence of these barometric disturbances suggest that they were caused by the great volcanic eruption of Krakatoa, in the Straits of Sunda.—Report on the Circumpolar Expedition to Fort Rae, by Capt. H. P. Dawson, R.A. (7 pp.).

Professional Papers of the Signal Service, No. XI. Meteorological and Physical Observations on the East Coast of British America, by Orray Taft Sherman. 4to. 1883. 20½ pp.

This contains the observations and deductions made by the meteorologist attached to the "Preliminary Arctic Expedition of 1877-78" in the schooner *Florence*, which was equipped by private enterprise. The observations, which extend from September 1877 to July 1878, were made at Ananito, in Cumberland Gulf, Arctic America.

Scientific Proceedings of the Royal Dublin Society. New Series. Vol. IV. 8vo.

Contains:—On an apparatus for obtaining telegraphically the readings of meteorological instruments placed at a distance from the observer, by J. Jolly (7 pp. and 2 plates).

Sitzungsberichte der kaiserlichen Akademie der Wissenschaften. Band LXXXIX. II. Abh. February 1884. 8vo.

Contains:—Einige Resultate aus Major von Mechow's meteorologischen Beobachtungen im Innern von Angola, von Dr. J. Hann (29 pp.). The station was at Malange, lat. 9°33′ S. and long. 16°38′ E.; and Major v. Mechow took careful hourly observations during 1879-81, supplementing these by additional observations at the turning points of the diurnal barometric curve. These are the only hourly observations we possess from Africa, except from Cape Town. The results are accordingly of rare value, and give a very good representation of the climate of this part of the interior of Africa.

Symons's Monthly Meteorological Magazine, Vol. XIX. Nos. 217-219. February to April 1884. 8vo.

The chief articles are:—The Storms and Barometric Disturbances, January 20th-26th (2 pp.).—The Atmospheric Disturbance, December 10th-16th, and its effects upon the barometer and the underground water at Maghull, Liverpool, by I. Roberts (2 pp.).—Another source of Volcanic Dust, by G. Davidson (4 pp.). This is an account of the volcanic eruption of Mount St. Augustine, Alaska, October 6th, 1883.—The Sunsets and the Java Earthquake (3 pp.).—January 1884 in the United States (3 pp.).—The Sun Glows, by H. A. Hazen (3 pp.).—White Frost followed by Gales (3 pp.).

The Weather of 1883 as observed in the Neighbourhood of London, and compared in all respects with that of an average Year. By Edward Mawley, F.R.Met.Soc., F.R.H.S. 1884. 8vo. 78 pp.

This contains tables of daily observations made at Addiscombe, Croydon, which are compared with the Greenwich averages. Mr. Mawley says that the year 1883, taken as a whole, may be briefly described as having been of average temperature, rather bright, and extremely dry, with a dry and very windy atmosphere. Barometric pressure was high. Low as the death-rate in London has been in every year since 1879, the year 1883 comes out as by far the healthiest of them all. Never have respiratory diseases in recent years proved so little fatal, and the same is equally true as regards those traceable to zymotic disorders.

Transactions of the Royal Society of Edinburgh. Vol. XXXII. Part I. 4to. 1883.

Contains:—Bright Clouds on a dark night Sky, by C. Piazzi Smyth, Astronomer Royal for Scotland (26 pp. and 13 plates). On April 8th, 1882,

some remarkably bright clouds were seen over Edinburgh, and on discussing the meteorological returns from various parts of Scotland, Prof. Piazzi Smyth finds that on that particular day a most unusual wave of dryness passed across Scotland.

ZEITSCHRIFT DER ÖSTERREICHISCHEN GESELLSCHAFT FÜR METEOROLOGIE. Redigirt von Dr. J. HANN. XIX. Band. February-April, 1884. 8vo.

Contains:—Beobachtungen über die Dämmerung, von Dr. G. Hellmann (21 pp.). This is an account of observations on the duration of twilight taken in Spain, from which it appears that the rule of a depression of 18° is not constant. The depression has a yearly period, with a maximum in winter and a minimum in summer. It is greater in the morning than in the evening, and it decreases with the relative humidity. Dr. Hellmann describes the phenomena of a normal twilight, and draws especial attention to the *anticrépuscule*, the twilight appearing on the eastern horizon, to which Mr. Russell referred in his paper.[1]—Ueber das Klima von Algerien, nach A. Angot (8 pp.).—Ueber die ausserordentlichen Dämmerungs-Erscheinungen (16 pp.). Several notices of the unusual twilights are given, with a note by Dr. Hann, pointing out that there is no local account of the ejection of such a mass of dust as would produce so extensive a phenomenon. A translation of Mr. Scott's and Gen. Strachey's papers in the *Proceedings of the Royal Society* is also given.—Teisserenc de Bort über abnormale Winter (8 pp.).—Gang der Isothermen im Herbste im Norden Europas, von A. G. Högbom (3 pp.). This paper is on the receding of temperature in autumn, which is very interesting as compared with Hildebrandsson's on the advance of temperature in spring. The most important fact is that the advantage of an insular climate is more marked in the autumn than in the spring.—Ein Beitrag zum Thema "Sonnenflecken und Regenmengen," von v. d. Groeben (8 pp.).—Klima von Norwegen, von H. Mohn (10 pp. and plate). This is an analysis of the results of the various observations carried on in Norway since the establishment of telegraphic weather reporting in 1867. The isobaric charts extend over the Atlantic to Greenland and Iceland; and the paper contains temperature data for the same area.—Das Schleuderpsychrometer von Dr. R. Assmann (8 pp.). This is a note on the use of the principle of the sling thermometer for a hygrometer.

[1] *Quarterly Journal of the Royal Meteorological Society, Vol. X. p.* 139.

QUARTERLY JOURNAL

OF THE

ROYAL METEOROLOGICAL SOCIETY.

VOL. X. JULY 1884. No. 51.

BRIEF NOTES ON THE HISTORY OF THERMOMETERS. By ROBERT H. SCOTT, M.A., F.R.S., President.

[Read March 19th, 1884.]

I MUST commence by disclaiming any idea of attempting a complete account of Thermometry, as the Fellows are here to-night to see Thermometers, and not to spend too long a time listening to a dry record of their origin and construction.

I am the more disposed to be brief because the subject has of late years been very fully handled by one of our Foreign Members, M. Emilien Renou, in the *Annuaire* of the French Meteorological Society for 1876: in a paper in which one hardly knows whether to admire most the thoroughness of his bibliographical research, or the perfect fairness with which he assigns credit where justly due, without a trace of Chauvinism, or preference for his own country. M. Renou therefore I shall follow in much that I have to say.

The earliest notice of the thermometer dates from the latter half of the 16th century. Boerhaave, in his *Elementa Chemiæ*, 1732, states that it was invented by Cornelius Drebbel, of Alkmaar, who died in 1634, in London; and Santorio in Venice, in 1632, stated that he possessed an instrument which would indicate all the degrees of heat and cold of the atmosphere.

Unfortunately for these and other claimants to the title of Inventor, Dr. Robert Fludd, in his *Philosophia Moysaicà*, published at Gouda, in 1638, states that he possessed such an instrument, called *speculum calendarium*,

which was not an invention of his own, but of which he had found the description in a work then more than 50 years old; and Bacon, who died in 1636, spoke of a Thermometer by name, calling it *Thermometra*. Here then the invention is put back to 1587 or so, when Santorius was little more than a boy, and its author is not named. Santorius, however, was an eminent physician, and made the grand discovery that the temperature of the human body rose with fever.

All these thermometers were more or less air thermometers. They consisted of a bulb of some sort blown on a tube, the open end of which was immersed in water. The level of the water therefore rose and fell with changes of temperature, but the indications were of course affected by the pressure of the atmosphere.

Pascal, as early as 1648, had recognised this defect in the instrument, as he found that sometimes the water rose in the tube when the temperature rose, and *vice versâ* it fell when the temperature fell. He apparently was the next after Bacon to use the term "Thermometer;" but when he objected to the instrument he was unaware that the Florentine Academy was in possession of thermometers which were closed, and therefore independent of pressure. These were filled with spirit, and in the general principles of their construction were precisely similar to thermometers of the present day. In fact those of us who remember the Scientific Exhibition of 1876, will doubtless have admired the marvellous skill of the Florentine glassblowers, whose workmanship we, after the lapse of more than two centuries, can scarcely equal, certainly not surpass.

The instrument was in existence in 1618, as we learn from Galileo's correspondence, and it was called *calendarium vitrum*. Here then, as in the former case, the name of the actual inventor has not been handed down.

The Florentines from the first aimed at making the degrees of their thermometers fractional parts of the volume of the bulb, in fact exact thousandths, but as such a proceeding required that the volume should be taken at a definite temperature, physicists at once began to seek for such fixed points, so as to ensure the perfect comparability of different instruments.

The credit of the suggestion of both of the points now used, the epochs of change of state of water from the solid to the liquid, and from the liquid to the vaporous conditions respectively, belongs to our countrymen.

Robert Hooke, who, as my predecessor told us two years ago, invented the first pressure anemometer, announced in his *Micrographia* (pub. 1667) that he possessed a thermometer whose zero was placed at the point where water began to freeze. Here, then, is one fixed point.

Halley, in the *Philosophical Transactions*, 1693, proposed the boiling point of water for one fixed point, but he doubted the constancy of the freezing point. He, however, in the same paper proposed mercury as a good thermometric fluid.

It was Renaldini of Padua who first made thermometers with the two fixed points, such as we have now-a-days.

The next name we have to mention is that of La Hire, who had gone to Florence to learn how to make thermometers, and on his return to Paris announced, after a protracted series of observations, that he had succeeded in finding a fixed point for his scale—the temperature of the cellars of the Paris Observatory at a depth of 28 metres. We shall see that this temperature plays an important part in the history of Réaumur's thermometer.

Newton comes next on our list; and in the *Philosophical Transactions* for 1701 we find a paper, certainly from his pen, on the scales of thermometers, and in it he announces that his instrument, filled with linseed oil, marked 12° at the temperature of a man's blood. This is the first notice we possess of "blood heat" on the scale, and as the temperature is nearly 36° C., we may say that one degree of Newton's scale was three times a Centigrade degree.

Such are the earliest notices of the ordinary fixed points. We now come to the names by which the scales at present in use are known.

Daniel Gabriel Fahrenheit was born in Dantzic about 1681. He began by using a scale of 180°, with its zero at 48° F. now-a-days, making +90° at blood heat and −90° in snow and salt.

This scale he soon gave up by Boerhaave's advice in favour of one with 24° for nearly the same range. His zero was the temperature of the frost of 1709, which was the severest then on record; and his highest point, 24°, was blood heat. This he assumed to be the highest air temperature at which animal life could be sustained. We may suppose he thought that its blood would boil if the temperature rose above that point.

He then divided these degrees into quarters, and this gave him 96° for blood heat, a reasonably close approximation to the true value of the armpit temperature of a healthy subject.

Carrying on his inquiries, he found that water boiled at a point marked 212°. Such was the origin of the famous Fahrenheit scale, the oldest, if not the most scientific of the three which have come down to our times.

Leaving alone the speedy recognition of the fact that the boiling point depended on the pressure of the atmosphere, and the practical discovery of barometrical hypsometry in 1789 by Lemonnier—a discovery which was completed by De Luc in his Alpine researches—we come to Réaumur, who from the first adopted a division into eighty parts; but he had a large spirit thermometer, and he made his zero point that at which a vessel of water, cooled by snow and salt, began to freeze, and the highest point the boiling point, not of the water, but of the spirit which he used, and which was far from being absolute alcohol, for the strongest spirit then known was "proof" spirit, that which just fired gunpowder. Réaumur's 80 degree point on his first thermometers has been found to correspond to 73° R. of the modern scale.

After a time Réaumur altered the mode of construction of his instruments, and took for his zero the point at which ice began to thaw naturally. These thermometers did not accord with his previous ones: he never announced the change of his methods of construction, and as he gained a great reputation, the world became supplied with Réaumur's thermometers, the indications of which were considerably at variance with one another.

It was, however, De Luc who pointed out that Réaumur's process was imperfect, and who himself prepared thermometers of the same graduation, but constructed on more correct principles. He also took account of the barometrical pressure in determining the boiling point, so that the more important conditions of correctness of fabrication were fulfilled.

It is very amusing to see the importance which was attracted to La Hire's fixed point, the temperature of the cellars of the Paris Observatory. All the old thermometers were tested by this, and Lavoisier in 1783 especially carried on a series of comparisons. A thermometer made by him at that time is still in those cellars in good condition, with others made by Guy Lussac.

Lastly we come to the Centigrade thermometer, which is generally attributed to Anders Celsius, of Upsala. His thermometer, however, marked 0° at the boiling point and 100° at the freezing point, and this is not the Centigrade scale as we have it. The honour of proposing this, the most scientific division of the thermometer scale, is due to a man to whom biological science owes a deep debt of gratitude, to Professor Linné, of Upsala, or as we generally term him, "Linnæus." Documents preserved at Upsala incontestably prove this, and Arago was the first to assign the credit of the proposal to the man to whom it justly belongs.

The air thermometer in its various forms, or the different modifications given to Nobili's thermo-electric pile in order to adapt it to meteorological registration, would take me into too much detail were I to attempt to describe them.

The so-called metallic thermometers, however, which depend on the expansion of solid metals instead of mercury, at one time promised great service. There have been two great divisions of these instruments.

I. Those which acted by the pressure of a bar on a system of levers, which measured the expansion by an arm on a dial. By this apparatus Musschenbroek determined the expansions of several substances.

II. Those which acted by the distortion produced by heat in a plate or bar composed of two metals of different expansive co-efficients soldered together. The first man who made such a thermometer was Jas. Crichton, in 1803. Then followed the Breguets in 1817, and about fifty years later, Hermann and Pfister, of Berne, produced their spiral thermometer, which marks maximum and minimum temperatures.

These instruments in their general forms are easily adaptable to registering apparatus, as there is abundant mechanical force to move the indices, and they have frequently been used; but unfortunately the most recent and careful comparisons, conducted in Austria and Switzerland between these thermometers and mecurial instruments, show that the former are very sluggish, differing at times as much as $\pm 2^{\circ}\cdot 7$ F. from the latter, while the change in the indications from a rise to a fall, or *vice versâ*, sometimes occurs as much as two hours after the actual change of temperature. We must therefore, for the present, abandon the idea of obtaining the correct registration of temperature changes from this simple and convenient apparatus.

I shall now pass on to the various forms of self-registering apparatus, the idea of which is almost as old as that of the thermometer itself, for among the old instruments of the Accademia del Cimento at Florence there is a thermometer very similar to Six's.

By self-registering thermometers I mean instruments which register the extreme temperature reached, as distinguished from self-recording instruments which furnish a record more or less continuous. At the end of the seventeenth century, John Bernouilli, and some sixty years later Cavendish, proposed maximum and minimum thermometers, but of a very imperfect construction. In 1781, Six's thermometer came out, and has held its ground for over a century; of late years it has done first-class service in the form of deep-sea thermometers, of which we have more than one specimen in the exhibition.

Rutherford's thermometers, both minimum and maximum, were brought out also in the last century, in 1794. We have specimens of both in the possession of the Society, and exhibited. The maximum is not now used, but the minimum has kept up its character for excellence to the present day.

Casella's mercurial minimum is a beautiful instrument, but is dearer than Rutherford's instrument, and is difficult of manipulation, so that it has not come into very extended use. Those, however, who possess the instrument and are dexterous and careful enough to use it cannot speak too highly of its merits.

As to maximum thermometers, the first of those now used is Phillips' (1832), to which instrument M. Renou is singularly unjust, as he attributes the origination of the mode of registration by means of a separate portion of the column to Walferdin.

Negretti's maximum is generally more used in this country, and with the various modifications of which this mode of construction is susceptible, it seems likely to grow instead of falling off in general favour. The principle of cutting off the expanded portion of the column at any requisite epoch lends itself to many determinations.

It may perhaps strike the Fellows as strange that I have only mentioned English maximum or minimum thermometers, but even as late as eleven years ago, at the Congress of Vienna, I found that many foreign stations did not possess such instruments.

From self-registering instruments the transition to continually self-recording apparatus is an easy one, and the latter type of instruments are all of modern date. The earliest was apparently Wheatstone's, brought out in 1842. It was of course electrical, the thermometers were open ones, and the record was not continuous, but was obtained at any requisite intervals of time by causing a wire to pass down the tube till contact was made. This is the form of thermometer used in Van Rysselberghe's Meteorograph, where as is well-known the record is obtained by causing the dipping wire to carry with it a tracer, and engrave on a copper plate a line whose length gave the depth to which the wire had to descend.

I have already spoken of the defects which most of the forms of compound

bars or plates present when employed for the measurement of temperature, and as yet the most satisfactory mode of obtaining continuous registration of that element, if that is what is required, setting aside absolute accuracy in the observations themselves, is to be had in the photographic thermographs. Here, however, the necessity of placing the instrument close to a building, and of using very large thermometers, renders the indications always somewhat discordant with those of a thermometer of the ordinary size placed in a Stevenson screen beside the observatory.

ON THE ORIGIN AND COURSE OF THE SQUALL WHICH CAPSIZED H.M.S. "EURYDICE," MARCH 24TH, 1878. By the Hon. RALPH ABERCROMBY, F.R.Met.Soc.

[Read April 16th, 1884.]

THE squall which capsized H.M.S. *Eurydice* caused one of the greatest disasters which has befallen our Navy for many years, but, strange to say, its meteorological characteristics have received very little attention. Except a short letter on the subject by the author in the columns of *Nature*, the only other notice was a very valuable memoir on the history of the squall by the Rev. W. Clement Ley, in *Symons's Meteorological Magazine* for April, 1878, and afterwards in the *Nautical Magazine*, Vol. XLVII. 5. The most striking result of his investigation is given in two maps, showing the areas covered by the rain and snow associated with the squall at 10 a.m. and 8 p.m. respectively. The latter map is reproduced by his permission in fig. 1. In both maps this area takes the shape of a truncated cone, the squall being apparently connected with the commencement of the rain. In the latter map, the cone is curved like a horn, or like a portion of a crescent.

Though the positions of the isobars at 8 a.m. were carefully and accurately described, and both the surface and upper aerial currents surrounding the squall were specially noted, the relation of the isobars to the rain area was not commented on.

The most important addition which the author of the present Paper has received to the materials which were then available, is derived from the international charts issued by the United States Government, which embrace the greater portion of the Northern hemisphere. He has also availed himself of the results of his own investigations on the nature of V-shaped depressions, which have been undertaken since then. His researches entirely bear out Mr. Ley's conclusions, and in fact this Paper may be considered rather in the light of an addition to the work of that gentleman.

It will be convenient to describe (1) the general condition of the meteorology of the northern hemisphere for the four days, March 21st to 25th, 1878; (2) the synoptic conditions of the complicated weather system on March 24th, to which the *Eurydice* squall belonged; and (3) the sequence of

weather observed at different stations during the day; and after that to endeavour to show the connection of the whole.

In all the charts for these days, the normal Atlantic anticyclone was found stretching far north till it nearly met another anticyclone lying over Greenland; and in each relatively low pressures were found over Northern Europe, and the Eastern States of the American Union.

On March 22nd each of these low areas contained a cyclone, one over Finland, giving Northerly winds and cloudy weather over Great Britain, the other about 800 miles west of Newfoundland. By next day, though the position of the Finland cyclone had hardly changed, its area had extended westwards, and the weather over our Islands became rather worse. Thus the barometer had fallen about 0·8 in. in some parts of England, but not owing to the passage of a cyclone.

On the other side of the Atlantic the Newfoundland cyclone had moved westwards—a very uncommon case.

By midday of the 24th the Finland cyclone had lost its definite shape, while another centre had formed over the Carpathians, and a complicated system of secondaries covered Western Europe.

It was in a squall associated with one of those secondaries that the *Eurydice* was capsized, as we shall presently explain in detail. Lastly, by next morning the two centres of the European cyclone had moved as if they were revolving round each other, or round a common centre, while the whole level of atmospheric pressure had risen, and the secondaries had much diminished in complexity. With these changes, and the rise of the barometer, the weather in Great Britain had much improved, but the wind retained its prevailing Northerly set. So far for the broad features of the weather, but it is necessary now to go into more detail for the day in question.

In fig. 2 we give a synoptic chart for 8 a.m. on March 24th, 1878. The centre of the Finland cyclone lies near Stockholm, and gradients for North or North-west winds are found over Great Britain. Influencing our Islands there seem to be portions of three secondaries with centres, one near Wick, another near Antwerp, and a third near Brest. The weather, owing to their action, is squally, with rain or snow in some parts, but blue sky in others.

By 0.48 p.m. (fig. 3) no definite centre is found for the primary cyclone, but the secondaries have much increased in intensity and complexity. The Wick secondary appears to have enlarged and moved a little south; the Brest one has rather contracted, but hardly changed its position; while the Antwerp one is probably represented by a secondary which was then near Paris.

But in addition to these, two new ones have formed over the South-east of England. The one which most concerns us is of the class known as V-shaped secondaries; its trough stretches from the Wash to the Severn, and is marked by a dotted line in fig. 3. It will be particularly noted that, on the whole, the wind, in front and near the trough, is more from the West than in rear, where it blows more from the North-west or North. Also that there are more symbols marked *s*, for snow, in its rear than in its front.

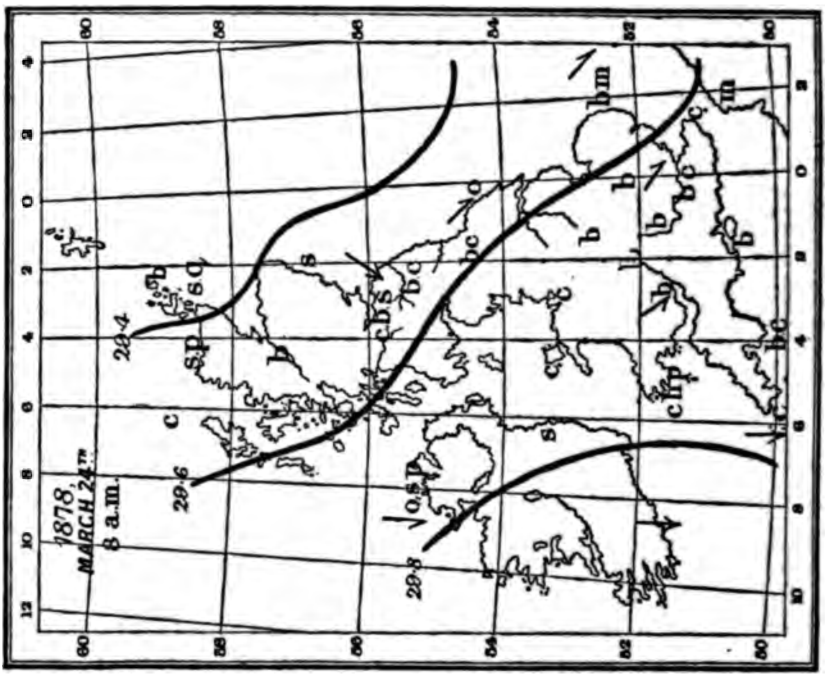

1878, MARCH 24TH 8 a.m.
29·4
29·6
29·8

Fig. 2.

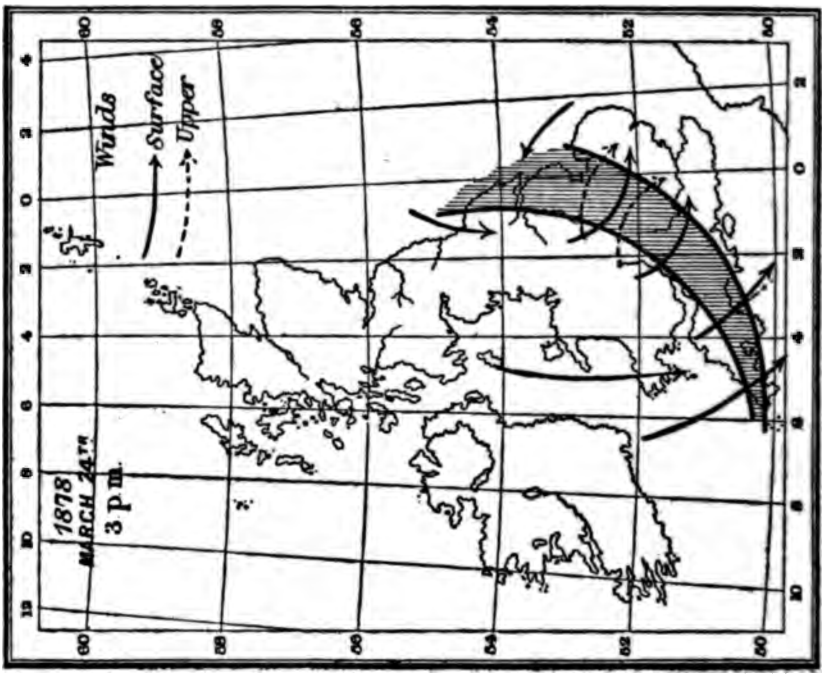

1878 MARCH 24TH 3 p.m.
Winds
Surface
Upper

Fig. 1.

FIG. 3.

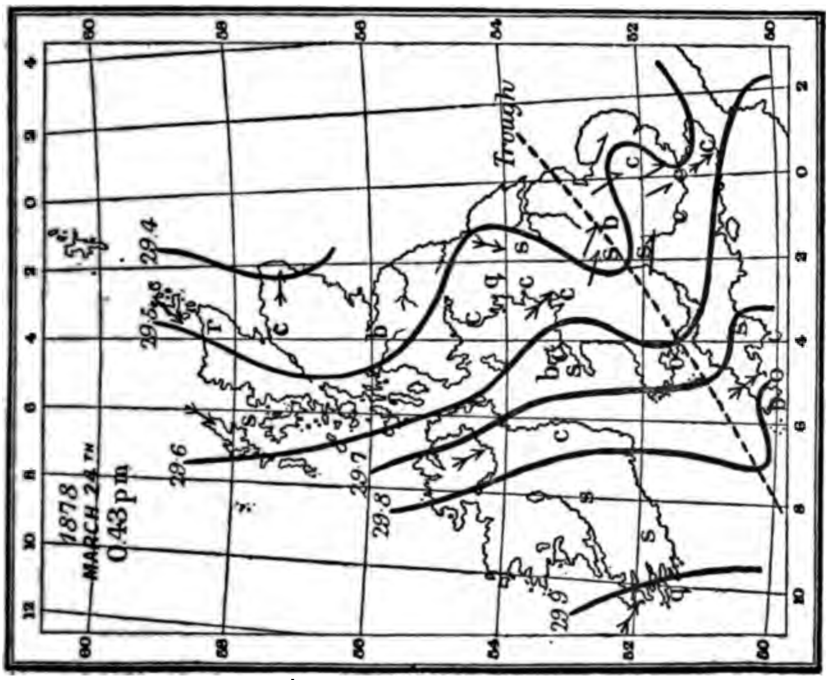

1878
MARCH 24TH
0.43 pm
Trough
29.4
29.5
29.6
29.7
29.8
29.9

FIG. 4.

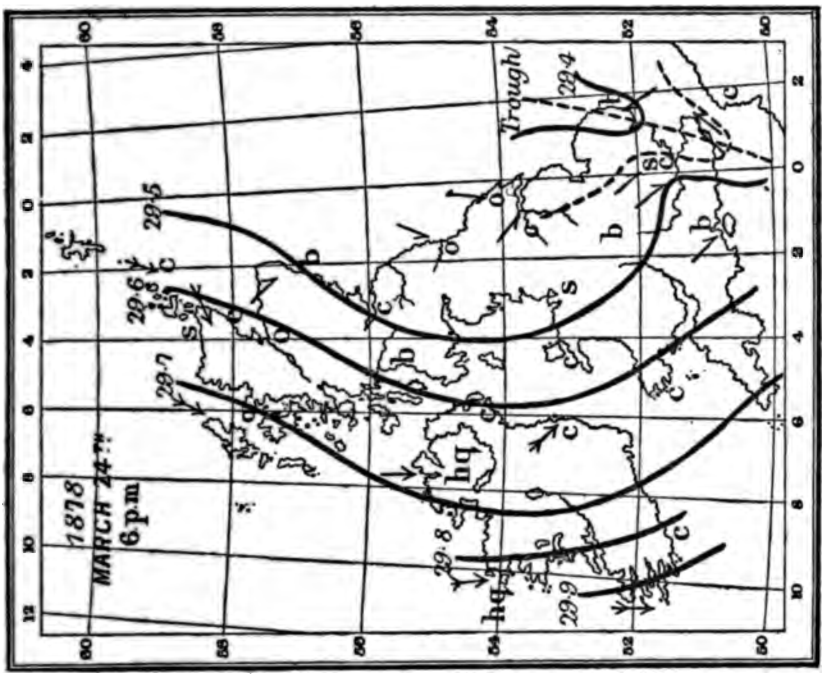

1878
MARCH 24TH
6 p.m.
Trough
29.4
29.5
29.6
29.7
29.8
29.9

Fig. 4 gives the isobars and weather for 6 p.m. on the same day, by which it appears that the Wick secondary had moved still further south, and that all the four secondaries found at 0.48 p.m. over the south of England and the north of France had coalesced into one larger V-depression, the trough of which now just skirts the south-east of England, and is marked by a dotted line in the diagram. The other dotted line is an interpolated isobar of 29·45 ins., which it was desirable to draw, so as to mark the very peculiar shape of the isobars. Confining our attention to this V only, it is seen that the wind is from South-east to South-south-east in front of the trough, with cloudy weather, and from North-west with snow in the rear of the trough.

Taken as a whole the trough of the V appears to have wheeled round a distant centre near the Scaw, so that while the portion between the Wash and Yarmouth has only progressed at the rate of about thirteen miles an hour, the portion which travelled from the Severn to Normandy moved at the rate of nearly forty-eight miles an hour, and the portion which swept over the Isle of Wight at the rate of thirty-eight miles an hour. The *Eurydice* was capsized in a squall off the Isle of Wight at 3.45 p.m., that is, at about the middle of the interval between the two last charts. We must therefore endeavour to explain how the changes in the isobars, as shown in these charts, affected the sequence of weather as observed in the Isle of Wight and elsewhere.

As V-depressions are scarcely yet recognised by meteorologists as a characteristic form of isobars, it may be desirable to call attention to their leading features. They are so called, because in them the isobars which enclose an area of low pressure run into a point like the letter V. A typical example of the commonest form in this country is given in fig. 5. As the V moves generally towards some point of east, a line drawn through all the localities where the barometer, having fallen to its lowest point, has just turned to rise, is called the trough of the V, and is marked by a dotted line in the figure. In most cases this line is curved, the convexity being towards the direction of its motion. The wind in front of the trough is nearly from the South, and a little incurved to the isobars, while in rear the wind comes from North or North-west, and is very slightly incurved. The shape of the rain area is like the double shaded portion of the diagram, and the rim of cloud—single shaded in the diagram—between it and the blue sky further in front of the V, is very narrow. The extreme rear or western edge of the rain area is usually very sharply defined by the line of the trough, and this line is also usually marked by a squall or heavy shower,

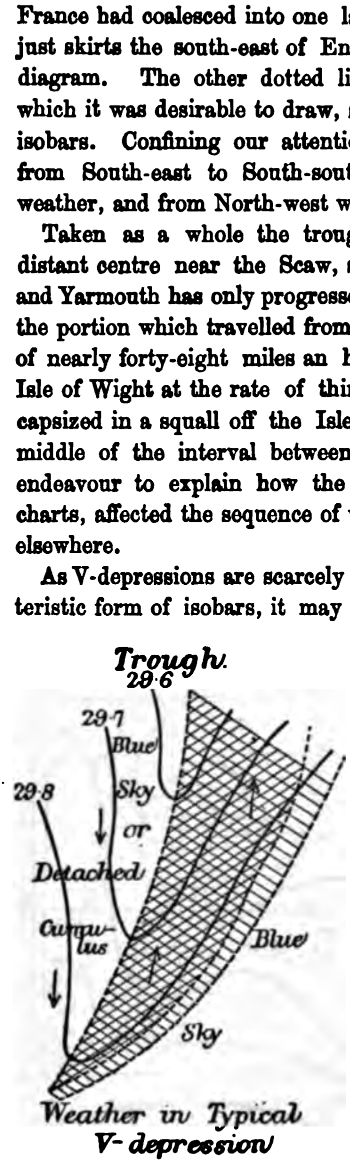


FIG. 5.

Immediately in the rear of the trough there is blue sky or cumulus clouds again.

The sequence of weather at any single station as a V-depression passes over will obviously be from blue sky through a very narrow belt of cloud to rain, with a nearly South wind and a falling barometer. Just as the barometer has reached its lowest point, a squall or heavy shower will be experienced, with a sudden shift of the wind to North-west, after which the sky will soon become blue again, as the barometer rises quickly. Thus viewed on a chart a somewhat crescent-shaped area of rain is seen sweeping across the country, coming on quietly but ending abruptly.

These Vs are usually formed along the southern prolongation of the trough of a cyclone, or in the "col" or furrow of low pressure which lies between two adjacent anticyclones. The most interesting circumstance concerning them is that they are entirely non-cyclonic, though in many respects they either resemble or differ from true cyclones.

In rare cases we find V-depressions which present a marked contrast to the normal type. In them the front of the V is characterised by cloudy weather only, or at least only slight rain with a falling barometer; the line of the trough is also marked by a line of squalls, after which rain falls pretty continuously for a short time with a rising barometer.

This class the author has only observed in connection with another secondary following close in the rear of the V, but they are so uncommon that he cannot generalise much upon them. In this case there is also seen on a synoptic chart a crescent shaped area of rain sweeping across the country, but the front of the area is bounded very approximately by the line of the trough, whereas in the former class the same line marked the termination of the rain. We can also picture to ourselves the idea of a line of squalls, in the case of the *Eurydice* more than 400 miles long, sweeping across the country at a rate varying from thirteen to nearly fifty miles an hour, and thus we can understand how London and Ventnor could be struck simultaneously. To this class belonged the V we are now discussing.

In case it may seem difficult to conceive two kinds of V-depressions with such opposite characters, the author ventures to make the following theoretical suggestion, for there are few observations on upper currents to guide us at present. Suppose that for whatever reason a South-west current meets a North-west one, it is quite reasonable to imagine that instead of both being deflected upwards, one tilts the other up, and remains horizontal itself.[1] In the common kind the South-west current would be deflected up, and the rain would precede the trough. In the rarer class, the North-west current would be tilted, and the rain would follow the trough.

With reference to the sequence of weather at different stations during March 24th, we quote from Mr. Ley's paper:—" A change of an important

[1] The Author believes that the idea of one current being tilted downwards was first suggested by Prof. E. D. Archibald, with reference to certain "North-Westers" in Bengal.

kind occurred in the snow storm during its transit. In the north of England, and as far as the Midlands, the snow began some time before the severe part of the squall. Thus at Stonyhurst the wind rose to fourteen miles an hour at 10 a.m. and reached thirty miles an hour at 11 a.m.; whereas in the metropolis, and in the south of England generally, strong gusts occurred with, or even before, the falling snow. In Leicestershire the wind rose slightly with the fall of the first snow flakes, but the actual squall, which I should estimate at force 7, did not occur till fifteen minutes later, and scarcely lasted twelve minutes. It is also noticed that in the north the wind continued to blow rather strongly at and after the end of the snow storm, *e.g.* at Stonyhurst it blew twenty miles per hour one hour after the sky had cleared; but in the south the wind, at the conclusion of the snow storm, subsided very quickly. This is clearly shown in the Beckley's Anemograph at Addiscombe, and Mr. Mawley remarks that 'at the same moment that it ceased snowing, the wind dropped even more suddenly than it had risen an hour and a half before.'

"As regards the direction of the wind on the Earth's surface at most if not all of the inland stations, the North-west wind which had prevailed at the earlier hours backed to a point South of West before the storm commenced, and veered suddenly northward (at most places to North-north-west and at a few temporarily to North-north-east) during the squall. At North Shields, which lay somewhat near the centre of the small secondary, at 9.30 a.m. the change of wind was from West-north-west to North. At Yarmouth, which experienced the centre of the small depression at 6 p.m., the wind changed at that hour from South-east to North-west. Snow is reported at this station to have fallen from daylight to dark. But at none of these stations on the east coast does the wind seem to have blown with much force, and nothing remarkable beyond the sudden veering seems to have been observed."

In London, the author's own observations were that the morning was cloudy with detached cumulus cloud. At 3.45 p.m. a squall which had obviously been brewing for some time burst with great violence, and lasted for about twenty minutes. It was followed by very threatening looking weather, during which the wind backed a little to West-north-west, having been North-west during the squall, but at 4.40 p.m. it shifted to North-north-east and became strong, with heavy snow, till 5.20, when the weather moderated.

The only barometric data available for our purpose is the copy of the Kew barogram, a portion of which is given in Mr. Ley's paper. From this it is seen that the barometer had been falling all day till 3.45 p.m., when it rose suddenly during the squall, as is usually the case, and then fell slowly to about its previous level, where it remained till 9 p.m., after which it rose steadily.

Mr. Ley gives in his paper the map of the area covered by the squall at 3 p.m. which has already been reproduced in fig. 1. He also gives a table of all the hours at which the snow storm began and ended at a number of places. From this table it appears that the storm had begun at so few places at 0.43 p.m. that it is impossible to draw a similar map for that hour. His

other map of the area covered by a snow storm at 8 a.m. shows that it then lay over a long patch of country, stretching across England from Berwickshire to the Mersey. The front of the area is sharply marked by a line drawn nearly from Shields to Liverpool. There is, however, no trace of this at 0.48 p.m.

H.M.S. *Eurydice* was a full rigged frigate, homeward bound from the West Indies. At 3.45 p.m. she was off Ventnor in the Isle of Wight, running free before a nearly Westerly wind, with all sails set; at that moment she was struck by a squall from the North-west. Before sail could be shortened she went on her beam ends, and the lee ports being open, she filled and foundered. So far for the actual observations, which must now be combined into a consecutive story.

First, as to the wind-changes. From the description just given, and an inspection of all the charts, there is no doubt that the squall was associated with a V-depression, and not with an ordinary secondary cyclone. Also, as all reports speak of the squall as occurring at the time the wind shifted suddenly, there is no question that the squall was of the kind associated with the trough of a V.

Then, as to the class of V, with regard to the position of the rain or snow area, the observations are not so easy to reconcile.

Mr. Ley's remark as to the snow preceding the squall as far south as the Midlands can only be explained either by the hypothesis that the V-depression actually changed its type during the day, or more probably that the apparent change was due to the complicated fusion of the V with some of the secondary cyclones, but there remains some uncertainty on this point.

The 8 a.m. chart (fig. 2) shows no sign of a V-depression, though it was then snowing at Shields and in the north-east of Ireland, owing to the complicated system of cyclones and secondaries then found over Great Britain.

By 0.48 p.m. the V-depression is already well pronounced, but there are no means of knowing to what circumstance the rain seen on Mr. Ley's map for 10 a.m. is due.

It will be observed that the front of the crescent-shaped rain-area in fig. 1 is more curved than the trough of the Vs in the synoptic charts. The map (fig. 1) of course only shows the land-area covered at 3 p.m. According to the table given in Mr. Ley's paper, the snow began at Falmouth at 2.45 p.m., so that the real front of the squall would have been out at sea. Allowing for this, the curvatures would nearly coincide; and considering that in some places a few flakes of snow may have fallen before the actual squall, and that with the high velocity of the western portion of the trough, a slight error of time would cause a large error in the position, the agreements between the two which have been obtained by totally different methods, may be considered fairly satisfactory.

The Kew barograph tracing, in so far as it shows that the squall really occurred at the trough or turn of the barometer, is very satisfactory, but it is not possible to give a complete explanation of all the curve. If there had been

no disturbing influence the natural barogram for the passage of a V-depression would obviously be a slight fall of the barometer till the trough passed, after which the mercury would begin to rise again. But in this case the situation is much more difficult to deal with, as the action of the primary Finland cyclone on the secondary V must be considered. The same remark applies to it as to the detail of weather in London, given above. After the twenty minutes the squall lasted a more complicated disturbance certainly set in, the details of which cannot be explained.

The results of this paper may be summarised as follows:—The squall which capsized H.M.S. *Eurydice* was one belonging to the class which is associated with the trough of V-shaped depressions.

The line of this trough was curved like a scimitar, the convexity facing the front. The whole revolved round a point near the Scaw, in Denmark, like the spoke of a wheel.

For this reason the portion of the squall over the East of England moved only at the rate of thirteen miles an hour; while the Western portion travelled nearly fifty miles in an hour. The portion which struck the *Eurydice* was advancing at the rate of thirty-eight miles an hour.

The length of the squall over England was more than 400 miles, but only one to three miles in breadth.

Hence we have the picture of a scimitar-shaped line of squalls, 400 miles long and about two miles broad, sweeping across Great Britain at a rate varying from thirteen to fifty miles an hour.

The V-depression was one of an uncommon class, in which the rain occurs after the passage of the trough, and not in front of it, as is usually the case.

The weather generally for the day in question was unusually complex, and of exceptional intensity, and for this reason some of the details of the changes cannot be explained.

DISCUSSION.

The Rev. W. CLEMENT LEY in a note to the Secretary said:—I have for many years been engaged in an investigation of the morphology of Squalls, the results of which I hope hereafter to lay before this Society. In connection with the present paper I wish now to point out that squalls of the same type as that which occurred in our Islands on March 24th, 1878, having a scimitar- or crescent-shape, are not uncommon in other parts of the world. I have called attention to this fact in a short article in *Nature*, Vol. XXVIII. p. 132. I would specially call attention to the charts of a squall on July 31st, 1877, contained in the *Special Bulletin of the Iowa Weather Service* for October 1877, and also in the *Notes on Cloud-forms and the Climate of Iowa*, by Dr. G. Hinrichs. The modifications undergone in the figure of the squall during its progress to the South-east are almost identical with those which characterised the Eurydice squall. Dr. Hinrichs remarks: "A storm peculiarly characteristic of our summers is the *squall*. It generally occurs after a continued spell of hot, rather sultry weather, the wind having blown steadily, but very moderately from the South or South-east—the barometer not changing much. In the North-west the storm-front will make its appearance; threatening, dark, towering clouds, or at times an immense roll-like cloud will approach; the air cools rapidly as the storm-front comes nearer, and with a high straight blow, bending young trees to the ground, and driving the rain almost level, the fierce storm passes over, while the barometer rises rapidly. Such a blow does not last long—but may be repeated with

gradually weakened force at intervals. A steady pouring rain generally follows, after which the sky clears, and the wind wheels back to the South-east, the weather being as hot as before the storm. These, often quite destructive storms, are not related to the so-called cyclones of modern meteorology, nor have they any thing in common with tornadoes. They are apparently due to the sudden descent of great masses of air from the upper regions, arriving at or near the ground with almost all the velocity peculiar to the high strata of the atmosphere."

The convexity of the front of these squalls frequently diminishes during their progress, as is shown in another of Dr. Hinrichs' charts for June 28th, 1881. I think that the increase and diminution of convexity are related to the increase and diminution of the general intensity of the weather, at the time, over the district traversed by the squall.

I further believe that squalls of this kind are invariably associated with depressions of the type described by Mr. Abercromby as "V-depressions," and that the "V-depressions" which produce this type of squall are usually shallow but of rapid movement, always forming the furrow of reduced pressure between moving adjacent anticyclones, but being further only secondaries of a larger cyclone (often itself very shallow), around the right-hand rear segment of which they revolve. I think it is going rather far to say with Dr. Hinrichs and Mr. Abercromby, that these V-shaped depressions are "entirely non-cyclonic." The fact pointed out by Mr. Abercromby in this paper, that the wind incurves in their front rather than in their rear (which I have long ago shown to be characteristic of European cyclones), coupled with the further fact, that the upper-currents, when affected by these depressions, back while the under-currents veer during their passage, seems to indicate that they are rather cyclonic than anticyclonic in character.

There appears to me to be no mystery about the V-depression, the formation of which seems an obvious result of antecedent conditions of pressure; but much mystery still hangs over the formation of crescent-shaped squalls.

Capt. TOYNBEE said that the sudden change of wind in connection with cyclonic systems is well known to sailors, so much so that when the barometer is falling fast and heavy rain has set in with a Southerly (South-easterly to South-westerly) wind in the northern hemisphere, a sudden change to West or North-west is expected. In the southern hemisphere the fast falling barometer and heavy rain occur with a Northerly (North-easterly to North-westerly) wind, and the sudden change is to West or South-west. In both cases the barometer generally rises quickly after the change. The data sent in for the daily charts of the North Atlantic now being prepared by the Meteorological Office prove this fact, as many captains have recorded the sudden wind-changes which they experienced. They generally occurred to the southward or south-eastward of the areas of lowest pressure, as shown by Mr. Marriott in his paper on the Storm of January 26th, 1884; his diagrams showing that a squall with lightning occurred in that position. It seems most probable that the heavy rain squall is caused by a collision between the warm damp air of the Southerly wind with the cold dry air of the Westerly or North-westerly wind. When revising his remarks Capt. Toynbee added :—May not the V-shaped depression be formed by a trough of low pressure which must exist between a North-westerly and a Southerly wind, when the North-westerly wind is advancing to the eastward and displacing the Southerly wind which is compelled to yield to it? There would of course be a perpetual squall of wind and rain accompanied by a sudden change of wind in this trough. The North Atlantic Charts already alluded to seem to indicate cases of this kind.

Prof. ARCHIBALD said there was little doubt that these V-shaped depressions were identical with what were known in India and elsewhere as North-westers. It had been noticed by Prof. Eliot and other meteorologists, that these storms invariably travelled in a direction contrary to that of the surface winds, and also that there was a marked fall of temperature and simultaneous rise of pressure at their centres. Prof. Eliot considered that this was due to the descent of a cold upper current in their central areas; and in alluding to this explanation in a recent article in *Nature* he (Prof. Archibald) had ventured to suggest that the upper current was probably tilted downwards by the sudden uprush of a mass of heated air travelling in the opposite direction.

Mr. WILFRID AIRY stated that he had acted as Secretary to the Wind Pressure Committee, and in the course of his investigations as to wind pressure he had collected together many observations respecting the *Eurydice* squall. He then read a statement of the pressure and direction of the wind during the passage of this squall at several places in Great Britain, and also exhibited a tracing of the record of the anemometer at Greenwich on that day, the change in the direction of the wind at the time of the squall, as shown by the trace, being extremely sudden. A very noticeable feature of the squall at almost all the places mentioned was the extreme suddenness with which it came on.

Dr. MARCET remarked that on the Lake of Geneva in the neighbourhood of that town, he had frequently observed sudden changes in the wind from South or South-west to West and North-west. The threatened westerly squall can be usually foretold from the presence of dark heavy clouds collecting over the Jura Mountain in the west; after a lull of the South-west Föhn, a line of dark and ominous looking cat's-paws from the western shore of the lake announce the impending puff. It seldom lasts longer than half-an-hour, although he had known this wind, which is called at Geneva the "Joran," last for three days in succession, blowing very hard the whole time. The "Joran" is dangerous to navigation on the lake, but from the state of the sky and general look of the weather, a careful navigator will always be warned in time to shorten sails.

Mr. WHIPPLE had a very clear recollection of the *Eurydice* squall, as he was out walking at the time of its occurrence, but he could not agree that it came on with extreme suddenness, for in fact he saw the approach of the snow, and had time to get nearly home before the squall reached him. If the *Eurydice* had been farther out at sea, instead of close to the land, no doubt the man on the look-out would have seen the squall approaching, and therefore, would have been able to give timely warning and possibly saved the ship. He thought that the term 'V-shaped depression' was not a convenient one, and suggested 'cusped' instead.

The CHAIRMAN (Mr. LAUGHTON) thought that the Fellows would be interested by the account of a remarkable squall, which was experienced by the *Talbot* frigate in the Mediterranean now forty-six years ago, and which seemed to have a certain resemblance to the squall under consideration. The *Talbot* was at the time commanded by Captain, afterwards Sir Henry Codrington, from whose letters, printed for private circulation, he would read the following:—

"On Friday, 14th September, 1838, about 2.30 p.m., the *Talbot* got under way from Smyrna. At first we were bothered with light variable winds; but getting well over to the northward, near the low land and marshy banks on the right hand, we picked up a nice moderate breeze from the northward, and then, with the wind about abeam, were running merrily along with royals set, the water being as smooth as a mill-pond. We had been setting the foretopmast studding sail, and were in the act of giving the last pull to tack and halyards, when it freshened a little. 'Lower the royals,' &c. At this time I was on deck myself, with a steady old lieutenant passenger also abaft, besides the officer of the watch, who was carrying on the duty; and looking to windward, I saw nothing on the water (the day being perfectly fine and clear) that I would not have carried whole topsails and topgallant sails to over and over again, and should do tomorrow. Suddenly it freshened. 'Topmen aloft, take in royals—lower the top-gallant sails.' Then instantly came a gust aloft, to which the ship heeled over at once. I had barely time even to sing out 'Lower the topsails—let go the main sheet' (and there was no time to execute the order) when with one crash all was over, things having been summarily settled. At one instant, the ship with her topsails at the mast head, and top-gallant sails not yet down, nor royals in, bowed down with her masts all a-taunto. At the next moment she was bolt upright in a calm, with her jib boom, fore and main topmasts, and every mast and sail above them, lying in fine *negligé* over her larboard side, while the mizen-topmast was looking over after them to see what had become of its companions." [Then follows a detailed and technical account of the wreck and refitting the ship.] "I don't think I've said much about the squall coming on. Neither myself nor friend (the steady old lieutenant passenger), though looking out to windward, saw any wind coming: the ship heeled comparatively very little, the water just for a moment coming in at the maindeck ports. On deck we felt no wind worth mentioning: nothing about courses or spanker was strained; only one wine glass slipped on the ward-room table, and I never was

more surprised than on hearing the crash and seeing every thing gone over to leeward. The fact is all the wind was above the lower masts." It would be noticed that from the suddenness with which the squall came on, the *Talbot* was taken unprepared, and heeled over, so that the water came in at the main-deck ports. The same was the the case with the *Eurydice*. Between the two ships, however, there was this very important difference : the *Talbot* had the old hempen rigging, which parted under the severe strain ; the ship shortened sail for herself: the *Eurydice* had the new-fangled wire-rigging, which unfortunately held fast, and the ship went to the bottom.

Mr. ABERCROMBY could not agree with Mr. Ley that a V-depression was in any way cyclonic. The wind was always incurved to the isobars which bounded an area of low pressure, whether cyclonic or not. If the opposite to a cyclone was an anticyclone, the antithesis of a V-depression was a wedge. In true cyclones, that portion of the trough which lay to the south of the centre was usually associated with a line of squalls, which has some points of resemblance, and others of contrast, with the squalls of a V-depression. In a cyclone, the wind has generally veered gradually from South-east or South to South-west before the sudden jump to West occurred. Besides this, there is the fundamental difference that cyclonic isobars are circular ; while those of V-depressions are angular. He believed that V-squalls were analogous to the "Nor-westers." of Bengal ; also to certain squalls on the Lake of Geneva, described by Dr. Marcet ; and to others in Iowa, referred to by Mr. Ley. The term V-depression is certainly a little awkward, but he did not think the word 'cusped' was more suitable. He had made it a fundamental rule in all his researches to classify isobars by their shape, and then group certain phenomena of wind and weather round these forms. He selected the word V-depression as exactly defining this shape of isobars. The great advantage of this method is that it avoids any theoretical considerations. The squall described by Mr. Laughton was not one of the line squalls which belong to a trough. It was, however, very interesting, as it showed how a ship could have her topmasts sent overboard, while little wind reached the main deck.

THE WEATHER FORECASTS FOR OCTOBER, NOVEMBER AND DECEMBER, 1883.

By CUTHBERT E. PEEK, M.A., F.R.Met.Soc., F.R.G.S.

[Read April 16th, 1884.]

THE comparative tables here presented have been prepared from data obtained as follows:—Each morning at 9h. 30m., after recording the usual meteorological observations, a report of the wind and weather of the preceding twenty-four hours was drawn up in words as nearly as possible on the model of those employed in the Forecasts of the Meteorological Office. This was entered in a journal kept for the purpose. The reports coming daily from the Office by post, usually arrived about 10h. 30m. a.m. on the day following that on which they were issued, so that the reports could never be seen till the twenty-four hours for which the forecast was made were close on termination, and for which the actual state of the weather had been previously recorded. The forecasts when received were entered in a column opposite the statement of the weather observed, and a free and independent comparison obtained.

As Rousdon lies very near the western boundary of the district of "England South," on the borders of Devon and Dorset, in latitude 50° 42 N, longitude 3° 0′ W, and 524 ft. above mean sea level, I had prepared a

duplicate table, supposing that the wind and weather here might be occasionally more accurately predicted in the Forecasts for England "South-west;" I was, however, gratified to find that this precaution was quite unnecessary, as in only two instances (October 1st and November 17th) were the South-West Forecasts more correct than those proper for the district.

Analysing the results for October, I find that out of twenty-six days on which forecasts were issued, both wind and weather were correctly predicted on ten days. During November, the number of forecasts being the same, there were again ten days on which the correspondence was exact; while in December, with twenty-four forecasts, the prediction was realised on eleven days. Thus, out of seventy-six forecasts, thirty-one were completely fulfilled.

During the three months there were fourteen days on which the weather was correctly predicted, the wind forecasts being more or less doubtful; bringing up the number of accurate weather predictions to forty-five.

The weather predictions were unreliable on thirteen days, and on the remaining eighteen days doubtful.

With regard to the wind, I find it accurately predicted, both as to direction and force, on twelve days in October, fifteen in November, and twelve in December, making a total of thirty-nine days.

Twenty days are classed as doubtful, and this includes several in which, though the direction of the wind was as predicted, the forecast of force was erroneous. On seventeen days the wind predictions were unreliable.

For the care taken in recording the observations necessary for the compilation of the above, I have to thank my able assistant, Mr. C. Grover.

TABLE—Showing the Value of Weather Forecasts for the District, England, South, from Observations made at the Observatory, Rousdon, Devon.

Wind 1883.									Weather 1883.								
Reliable.			Doubtful.			Unreliable.			Reliable.			Doubtful.			Unreliable.		
Oct.	Nov.	Dec.	Oct.	Nov.	Dec.	Oct.	Nov.	Dec.	Oct.	Nov.	Dec.	Oct.	Nov.	Dec.	Oct.	Nov.	Dec.
1	2	1	13	6	5	4	1	15	1	1	1	28	8	5	2	2	18
2	3	2	19	18	8	6	4	25	4	2	2	31	13	8	14	4	25
5	9	3	24	23	18	7	7	29	5	3	3	..	15	15	21	9	29
9	10	6	25	27	19	14	8	30	6	6	6	..	18	19	23	16	..
10	11	7	26	29	20	20	17	..	7	7	7	..	20	20	26	17	..
11	13	9	28	30	21	21	..	..	9	10	9	..	24	21	27	..	..
12	14	11	..	..	22	23	..	..	10	11	11	..	27	22	..	..	..
16	15	12	..	..	23	27	..	..	11	14	12	..	..	28	..	..	..
17	16	14	..	..	..	..	..	..	12	21	14	..	..	30	..	..	..
18	20	16	..	..	..	..	..	..	13	22	16	..	..	..	..	..	..
30	21	27	..	..	..	..	..	..	16	23	23	..	..	..	..	..	..
31	22	28	..	..	..	..	..	..	17	25	27	..	..	..	..	..	..
..	24	..	..	..	..	..	..	..	18	28	..	..	..	..	..	..	..
..	25	..	..	..	..	..	..	..	19	29	..	..	..	..	..	..	..
..	28	..	..	..	..	..	..	..	20	30	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..	..	24	..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..	..	25	..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..	..	30	..	..	..	..	..	..	..	..

The complete results for the three months in percentages are—

	Wind.	Weather.
Reliable	51·3	58·4
Doubtful	26·4	23·4
Unreliable	22·3	18·2
	100	100

APPENDIX.

The Weather Forecasts for January, February and March, 1884.

The tables here given were prepared in a similar manner to those of the last quarter of 1883—namely, by recording each morning the weather of the preceding twenty-four hours, and comparing it with the forecasts for the same period afterwards received.

During January twenty-six forecasts were issued. On eighteen days both wind and weather were accurately predicted. The wind forecast was accurate on twenty-one days, doubtful on three, and unreliable on two days. The weather forecast was accurate on twenty days, doubtful on five, and unreliable on one day. In February twenty-five forecasts were issued. On ten days both wind and weather were accurately predicted. The wind forecast was accurate on eleven days, doubtful on nine, and unreliable on five days. The weather forecast was accurate on sixteen days, doubtful on six, and unreliable on three days. In March twenty-seven forecasts were issued. On fourteen days both wind and weather were accurately predicted. The wind forecast was accurate on sixteen days, doubtful on five, and unreliable on six days. The weather forecast was accurate on twenty-one days, doubtful on three, and unreliable on three days.

Arranging these figures in a manner similar to those of the last quarter of 1883, we obtain the following percentage results:—

	Wind.	Weather.
Accurate	61·6	73·1
Doubtful	21·8	17·9
Unreliable	16·6	9·0
	100	100

By comparing the two periods, we find a great increase in the accuracy of these forecasts. Out of the seventy-six forecasts for October, November and December, 1883, both wind and weather were accurately predicted on thirty-one days; while of the seventy-eight forecasts for January, February and March, 1884, forty-two were equally accurate.

Moreover, it is worth remembering that during the quarter just ended we

have experienced one of the most violent storms of the last few years. The Gale of January 26th, 1884, will be long remembered as having swept over this district with extreme violence. The barometer fell to 28·526 ins., the movement of the column of mercury being distinctly visible, rising and falling with each successive gust of wind. Heavy rain, snow and lightning occurred, and it was some time before the barometer settled down from these great disturbances; a condition under which the issue of accurate forecasts might reasonably be considered a matter of more than ordinary difficulty.

TABLE—Showing the Value of Weather Forecasts for the District, England, South; from Observations made at the Observatory, Rousdon, Devon.

Wind, 1884.									Weather, 1884.								
Reliable.			Doubtful.			Unreliable.			Reliable.			Doubtful.			Unreliable.		
Jan.	Feb.	Mar.	Jan.	Feb.	Mar.	Jan.	Feb.	Mar.	Jan.	Feb.	Mar.	Jan.	Feb.	Mar.	Jan.	Feb.	Mar.
1	1	1	2	6	2	10	2	6	1	1	1	2	14	2	10	3	14
3	8	4	11	14	5	18	3	12	3	2	4	13	15	19	..	8	15
4	10	7	30	15	9	..	5	14	4	5	5	16	16	29	..	9	23
5	12	8	..	16	11	..	7	15	5	6	6	18	17	..	..	..	..
6	13	13	..	17	20	..	9	22	6	7	7	25	19	..	..	..	..
8	20	16	..	19	..	..	..	23	8	10	8	..	21	..	..	..	..
9	22	18	..	21	..	..	..	..	9	12	9	..	..	..	..	..	..
12	23	19	..	24	..	..	..	..	11	13	11	..	..	..	..	..	..
13	27	21	..	26	..	..	..	..	12	20	12	..	..	..	..	..	..
16	28	24	..	..	..	..	..	..	15	22	13	..	..	..	..	..	..
17	29	25	..	..	..	..	..	..	17	23	16	..	..	..	..	..	..
19	..	26	..	..	..	..	..	..	19	24	18	..	..	..	..	..	..
20	..	27	..	..	..	..	..	..	20	26	20	..	..	..	..	..	..
22	..	28	..	..	..	..	..	..	22	27	21	..	..	..	..	..	..
23	..	29	..	..	..	..	..	..	23	28	22	..	..	..	..	..	..
24	..	31	..	..	..	..	..	..	24	29	24	..	..	..	..	..	..
25	..	..	..	..	..	..	..	..	26	..	25	..	..	..	..	..	..
26	..	..	..	..	..	..	..	..	27	..	26	..	..	..	..	..	..
27	..	..	..	..	..	..	..	..	30	..	27	..	..	..	..	..	..
30	..	..	..	..	..	..	..	..	31	..	28	..	..	..	..	..	..
31	..	..	..	..	..	..	..	..	..	..	31	..	..	..	..	..	..

DISCUSSION.

Mr. C. Harding said there were many ways of testing the accuracy of weather forecasts, and he thought it was hardly fair to test the forecasts for a whole district by the weather experienced at a single station in that district. The forecasts issued by the Meteorological Office are tested in that Office, and the results show that about eighty per cent. of the forecasts issued are correct, which was a much larger percentage than Mr. Peek's results showed.

Mr. Strachan said he agreed that the paper threw no light on the practice of weather forecasting, still it was of value as an independent check upon the official forecasts, and he was glad to see a Fellow of the Society turn his observatory to such practical account. No doubt there would be disagreement among individuals as to the method of checking the forecasts, but any way they should be regarded as indicating merely the general features of the weather. Forecasting weather was a very difficult matter, not to be compared for accuracy with the scientific prediction of the tides. To predict the tides at any port, only two variables—the time and the height, had to be considered; whereas so many variables made up the weather that it was impossible to take them all into

account. He thought it was better for the public to check the forecasts than for the Office which issued them to test its own work.

The CHAIRMAN (Mr. LAUGHTON) thought that some of the gentlemen who had spoken claimed more for the official forecasts than the Office itself asserted. At a lecture at the Royal Institution last session Mr. Scott had explained that by reason of the great size of the districts there was much room for local differences, especially in the matter of rainfall, and that he thought eighty per cent. of successes, whole or partial, was as much as could reasonably be expected. Mr. Peek's observations, taken at a station almost on the boundary of the district, gave, in round numbers, this eighty per cent. of successes, whole and partial, and must be considered as a very interesting testimony to the correctness of the forecasts.

ON CERTAIN EFFECTS WHICH MAY HAVE BEEN PRODUCED IN THE ATMOSPHERE BY FLOATING PARTICLES OF VOLCANIC MATTER FROM THE ERUPTION OF KRAKATOA AND MOUNT ST. AUGUSTIN. By W. F. STANLEY, F.R.Met.Soc., F.G.S.

[Read April 16th, 1884.]

SINCE the period of the Great Volcanic Eruptions in the Sunda Straits from the 25th to the 27th of August, 1883, it is well known that a continuity of remarkable atmospheric effects has been generally observed in all parts of the globe. These effects, particularly evident in the mornings and evenings, have been so carefully observed and discussed in a Paper before this Society by Mr. Russell,[1] that I shall not feel it necessary to offer any description, but merely speak of them as known effects.

It has been very generally thought throughout Europe and America, that the peculiar atmospheric effects observed must be in some way due to the eruption of Krakatoa. This opinion is strongly supported by the fact that these peculiar effects were first observed in the neighbourhood of that volcano, and that very similar effects were shortly afterwards observed at a greater distance, as in India, in the deeply tinted atmosphere accompanied by the "green sun" at the early part of September; but the peculiar atmospheric effects did not appear to attract observation in this country earlier than the 9th of November. The volcanic matter, therefore, if such be the cause of these abnormal atmospheric conditions, took a long, although possibly a natural, time to diffuse itself, by the means of aerial currents, sufficiently to reach this part of the world.

Following the eruption of Krakatoa on the 6th of October, there was a very considerable eruption of Mount St. Augustin in Alaska. This mountain, like Krakatoa, projected into the atmosphere an enormous volume of light volcanic dust, which fell copiously even at as great a distance as 700 miles from this volcano.[2] It is quite possible, therefore, that the atmospheric conditions observed in this country early in November may be partly attributed to this latter eruption in combination with that of Krakatoa.

[1] *Quarterly Journal*, p. 139. [2] *Nature*, March 6th, 1884.

The theory that such effects as have been lately observed may be due to volcanic matter suspended in the atmosphere is considerably strengthened by the fact that similar phenomena of after-glow to those recently witnessed were observed in Europe after the great eruptions in Barbadoes and near Sicily in 1831, in which also an immense volume of volcanic dust was thrown into the air.[1]

I think if we further consider this subject upon its own merits, without reference even to theory, that under any conditions eruptions of the character of Krakatoa and Mount St. Augustin, where in each case many millions of tons of fine dust and steam were projected high into the air within a short period of time, that the projected matter, so long as it remained suspended in the atmosphere, must necessarily produce distinct effects upon the light of the sun passing through it, or reflected from it. I think it may therefore be very well taken as a *vera causa* for such abnormal atmospheric effects as have been observed.

As regards that part of the peculiar optical effects in the air that may be due to steam only, which was evidently discharged in great volume in the eruption of Krakatoa, it may be argued from certain analogies which are in the highest degree probable that some part of the earlier observed atmospheric effects, particularly that of the "green sun," were due to the presence of steam in the atmosphere, as originally suggested by Mr. Lockyer.[2] But as the vapour of water forms at all times a part of the atmospheric system, it may be imagined that this would speedily enter into the general system of aqueous vapour always present, and bring about normal conditions, so that the amount of steam discharged from this volcano would not produce more than a local or transient effect.

With regard to the solid matter, the consideration of which is the particular object of this Paper, it must be imagined that even the smallest particles of dust would gradually subside by gravitation. But as these particles could not change their state (like steam when condensed) they must always maintain their initial forms and magnitudes, so that if there was any effect of refraction, reflection, polarisation, or general dispersion of the sun's light which they would at one time produce in the atmosphere, they would continue to produce this effect so long as they were suspended.

It was upon the strength of the above indisputable condition, and bearing in mind the constancy of the phenomena observed at different times in our own country, that I have come to the conclusion that the phenomena witnessed so generally over a large part of the globe must be due to particles of solid matter only, if they could be attributed in any way to the eruptions of Krakatoa and Mount St. Augustin; and this conviction led me to follow the matter in that direction only.

As regards the suspension of solid matter in the atmosphere, it must not be

[1] See Paper read before the Academy, Paris, by M. G. Tissandier, Feb. 5th, 1884, *Comptes Rendus*, p. 87.

[2] *Nature*, Oct. 11th, 1883, page 575.

overlooked that there is a great difficulty in defining the conditions under which this volcanic dust may remain suspended, and of this I am unable to do more than offer suggestions further on. But it is known, as a matter of fact, that solid particles are lifted from the earth by aerial currents, and carried to great distances; there is also evidence that particles of ice in cirrus clouds are supported and carried along horizontally in very attenuated atmosphere. Light volcanic matter may therefore be likewise supposed to be carried under somewhat similar conditions.

As preliminary to this investigation, I procured from friends a specimen of volcanic dust from Krakatoa of which I was sure of the authenticity, collected on board the *Norham Castle*, which fell to a depth of about 18 ins. in twenty-four hours, at fifty-seven miles from the eruption on the 27th of August. I was also fortunate in obtaining a very small quantity of dust, which fell to the thickness of about ½ in. in twenty-four hours on the deck of the *Arabella* on the 28th of August in lat. 5° 37′ S. long. 88° 58′ E.; that is, about 1,000 miles from the eruption. The particles of this latter dust would of course be of the forms more capable of suspension in atmospheric currents than the dust collected nearer the centre of eruption.

Of the dust collected on the deck of the *Norham Castle*, this appears to resemble the usual form of volcanic dust, and to be of a kind of volcanic glass (obsidian) blown into bubbles (pumice) and broken into minute fragments. In the specimens exhibited there are many crystals of augite, and crystals and splinters of felspar of the plagioclastic system. These crystalline mineral matters (not glass) appear to be present in greater quantity in dust collected nearer the volcano. In some volcanic sand which I have seen, taken from very near Krakatoa, these crystals formed the greater part of the mass. In specimens taken on board the *Arabella*, 1000 miles distance, they nearly disappear—at least they do so in the small quantity of dust that I was able to obtain.

The quantity of dust which I obtained from the *Norham Castle* was quite insufficient for quantitative analysis, but sufficient for me to discover that it was mainly silica with a large percentage of alumina, and traces of potash, soda, and lime. Under the blowpipe it forms a bright green glass bead.

Of the dust collected on board the *Arabella*, to which I wish particularly to call attention, the particles are generally thinner in section than those of the *Norham Castle*, and therefore, as might be supposed, likely to be carried by the air to a greater distance. This dust also contains finer concrete masses; at the same time there are a greater number of thin plates of about equal thickness throughout, and a number of plates thick on one edge or on one corner only.

If I might venture upon a suggestion as to the formation of the lighter or thinner particles contained in the specimen, which appear exactly to resemble particles of pumice except in the thinness of the plates, I would suggest that these are of pumice that had been more blown out, until the separate bubbles burst, under the following conditions:—that these thinner lighter parts were possibly projected from the centre of the volcanic chimney and were carried at

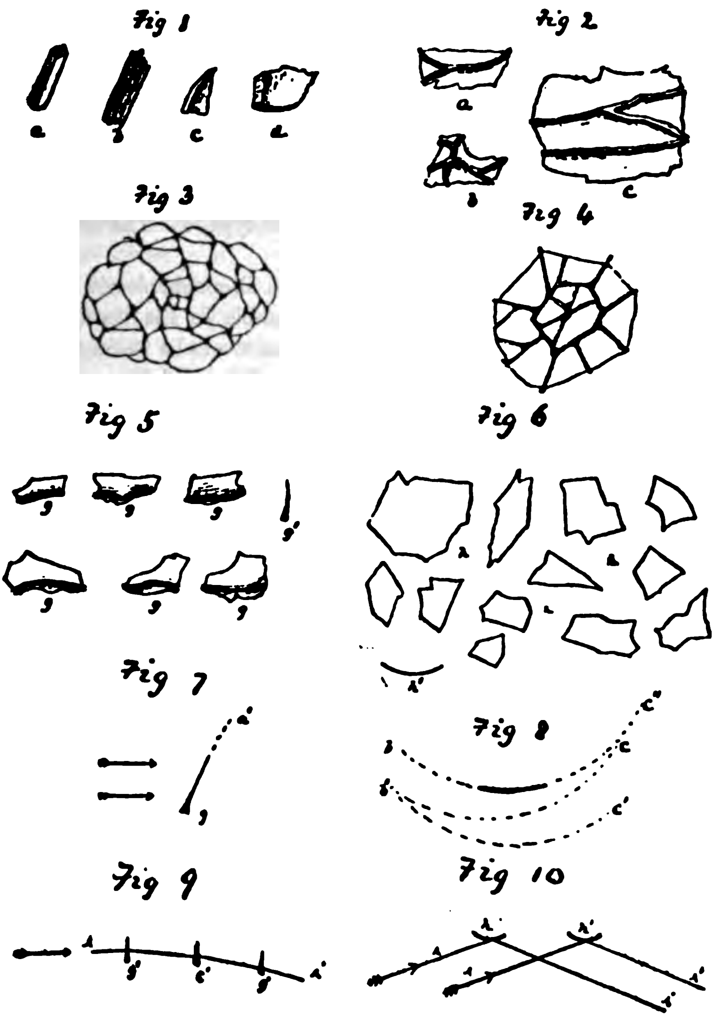
a melting temperature high into the atmosphere, where when liberated the external pressure would permit the included gases to dilate to a great extent before bursting the heated glassy bubbles which surround them. Whereas the pumice that it otherwise resembles (except in surface density) was thrown out nearer the surface of the volcanic chimney, was by contact with the cooler chimney cooled down considerably before exit, and was finally thrown out into the lower dense atmosphere, where external pressures would react upon the internal vapour force to a much greater degree than in the more central higher projections first described, and thus form a crust, retaining the pumice in a more concrete form. I must nevertheless admit that in the central parts of masses of pumice equally fine porous structure may be detected, but in this inner part again it may be imagined that the internal pressure is relieved by the condensation of outer parts, and altogether that the inner parts being confined by the denser parts, it could not be projected in the air in volcanic dust from the central position of any mass we may presume projected from a volcano.

It is customary to speak of volcanic dust in an indefinite manner, as though it were ordinary mineral dust, that is, of like construction throughout. But if the forms of the separate particles be analysed, it is found that these forms are systematically different. We are also able, by the tenuity of the particles and otherwise, to attribute very different powers of floating in the atmosphere to separate particles, as also very different optical properties. Therefore, some forms may be conceived to be much more suited than others to produce the atmospheric effects which form the object of this inquiry. Indeed, we do not find much difficulty in discriminating several kinds or rather classes of particles. Neither is it very difficult to discover the primitive forms from which many of these are derived, as so many parts appear to match each other in a general system. I therefore propose the following division of the classes of particles of volcanic dust:—

a. Small masses and crystals of mineral matter, augite, felspar, &c.
b. Chips and thin plates of the above.
c. Small masses of pumice.
d. Fractured chips of the above.
e. Light and overblown pumice.
f. Fractured parts of *e* containing thick seams.
g. Fractured parts of *e* thick on one edge or one corner only.
h. Plates of *e* with curved surfaces and of equal thickness throughout.

As my object is to discover the particles that will most readily float in the atmosphere, I shall now discuss only the volcanic dust that fell on the *Arabella* at one thousand miles distance from Krakatoa. I shall confine my discussion to the single microscopic slide of this dust exhibited to the Meeting. It will also readily be seen that the larger and more solid particles would be most easily influenced by gravitation, so that we may imagine that the smaller and lighter particles alone would be those suspended for the longest period, and that there may be lighter dust even than that collected.

Fig. 1, *a*, *b*. Small masses and crystals of mineral matter, consisting of



EXPLANATION OF FIGURES.

Fig. 1. *a*. Crystal of Augite; *b*. Crystal of Felspar (plagioclase); *c*, *d*. Chips. *Arabella* × 150 dia.

Fig. 2. *a*, *b*. Parts of union of glass bubbles; *c*. Surface of flat bubble fins. *Arabella* × 150 dia.

Fig. 3. Section of glassy froth.

Fig. 4. Imaginary splitting up of a bubble surface.

Fig. 5. *g*, *g*, *g*. Plates thick on one edge; *g′*. Section of plate. *Arabella* × 150 dia.

Fig. 6. *h*. Bubble plates; *h′*. Section of plate. *Arabella* × 150 dia.

Fig. 7. Chip of bubble plate with thick lower edge in a current.

Fig. 8. Gyration of bubble plate, *h*, to a lower level.

Fig. 9. *g′ g′*. Bubble plates with thick edge; *c′*. Mineral chips; λ to λ′. Refracted ray of light.

Fig. 10. *h h′*. Bubble plates; λ λ′. Ray of sunlight reflected at *h h′*.

very small particles or crystals of augite and felspar, may be found even in dust collected on board the *Arabella*, forming about one-half to one per cent. of the mass. More generally the crystallised mineral matters exist in wedge-shaped chips, or thin plates: to these latter I shall again refer. Two of the solid particles are shown above, magnified 1,000 diameters, *a*, *b*.

Small masses of pumice and chips. A great many particles quite resemble ordinary pumice; these are generally of the honeycomb type, *c*, but there are also present particles of the drawn or striated type, *c'*. The chips are from more solid glassy particles, *d'*.

Fig. 2, *e*, *f*, *The light or overblown pumice*, although, clearly indicated, is not to be found complete even for a single bubble in the specimen I have from the *Arabella*; but a vast number of parts are to be found, so that there is no doubt of the original construction: three of these plates are represented in Fig. 2. The complete form was evidently a frothy mass, which may be best represented in diagram of which Fig. 3 represents a thin section only.[1]

Fig. 3.—If it be imagined that these bubbles were overblown by causes already discussed, the separate parts will form the following particles, which, being lighter than any other, are those most capable of maintaining themselves against gravitation in the atmosphere.

Fig. 4.—*Fractured parts of light pumice.*—One class of these consists of an immense number of pieces upon which part of joining seam is present upon one edge, as though each separate bubble had broken in the thinnest, and simultaneously in the thickest part, as shown by openings in the diagram, Fig. 3. These last present more or less wedge-shaped forms; six of these, as drawn from the slide under the microscope, are depicted in Fig. 5. The last, *g'*, is one of the same plates seen in section.

Fig, 5. *Plates.*—These, which are the lightest particles in comparison with their surface, I consider to be of the greatest importance. These appear to be surfaces of bubbles externally free from thick edges; they have generally a slightly curved surface, and are of much thinner substance than any particles of pumice except those before mentioned in the very central parts of masses. They are, I presume, entirely parts of the overblown bubbles that I conceive to have been ejected from the centre of the crater of the volcano. These plates generally measure in different directions from 0·5 to 0·05 millimètre. The thickness varies from ·002 to ·001 millimètre, from careful measurement of about twenty specimens. The forms of these plates are often nearly square, although there are types of all the other forms incident to fracture. Twelve of these plates, shown in fig. 6, have been drawn to scale with the *camera lucida*; the last figure, *h,'* is placed to give an idea of the relative dimensions of section to that of surface.

Floating qualities of the particles.—I suppose as a general principle that the smallest parts with the largest relative surface to their masses will be

[1] The arrangement of microscope best adapted to show these bubble plates is ¼-inch objective achromatic condenser, cap over condenser with pin-hole centre, using diaphragm with ¼-inch aperture.

most likely to float, as this is a generally acknowledged principle, and is demonstrated in that gold leaf, one of the densest materials, floats in an aerial current. I therefore think it may be assumed that the essentially floating particles will be those described, g and h. These particles in floating will no doubt follow the laws of gravitation in settling in a resisting medium by keeping their centres of gravity as low in the horizontal plane as possible. Thus the particles g will maintain a nearly erect position, with their thickest edges downwards. The thin equal curved plates, h, will fall with their convex curved surfaces downwards.

Fig. 7. We can imagine that when the wedge-shaped particles are disturbed by currents, the lighter thinner edge will by its inertia be at first blown over, and in this position, the thin edge of the wedge being directed upwards, there would be a certain tendency to project the particle upwards in the direction of least resistance consistent with its form. Thus a force acting in the direction of the arrows shown in fig. 7, moving a wedge-like film g towards a resisting medium A, would have a certain amount of tendency to throw this particle upwards towards a'. With regard to the thin plates, the natural tendency of such, in falling in a resisting medium, would be to gyrate backwards and forwards, gaining at each gyration a lower position.

Fig. 8. Thus a plate would move in gyration from b to c and c to b' and thence to c'. But if such a particle were struck by a current in the direction of the arrow, the plate would be drifted much higher in its gyration towards c'', and there would continue to be a tendency to carry this particle to a higher level, so that I think the above forms g (fig. 7) and h (fig. 8) are such as are especially adapted to remain floating in the atmospheric currents.

Optical properties of the particles g and h.—First taking the types of the particles g (fig. 7) and h (fig. 8) together, g as a vertical wedge, h as a hollow disc, in which we may also include the mineral flakes c a (fig. 1), it will be seen that the sun's rays from anywhere near the zenith would be reflected from these wedges-like forms at a small angle, whereas it would pass directly through the discs h, and produce no visible result. Now as such reflection as might be produced by the wedge forms in bright sunlight would only aid in the general dispersion of light which exists at all times from the presence of solid and liquid particles in the air, by which we obtain light in all our windows, those placed from the sun, as of those towards it, the only effect that such reflection or dispersion would produce would be generally to diffuse light and weaken shadows; but I do not anticipate that the amount of suspended dust from the late volcanoes would be appreciable in this direction when the altitude of the sun was great.

Fig. 9. When the sun sinks low towards the horizon the optical properties of the particles g and h become more important. Under this condition the particles g and c, a not only disperse light but they are of such forms as to act as perfect refractors, bending the rays over towards the thicker edges as shown in fig. 9, in which three imaginary particles are shown consecutively refracting the beam. By this means the sun's rays would be retained in the atmosphere long after the setting sun, and as the refractions are of small angle the red rays of the spectrum only would be refracted.

Fig. 10. If we now consider at a like low angle of the sun to the horizon the effect upon the disc-like plates *h* described, of which there are such a great number in the *Arabella* specimen, we find that these would act as reflectors, and reflect the light of the sun long after it had sunk below the horizon. This is seen in the diagram, fig. 10, for two plates *h* and *h'*. It will also be seen that the sun's rays λ λ' will be nearly, or at a certain point quite, coincident with those described above for the wedge-like shapes. Therefore the optical effects of the one kind of particles would be materially supported by that of the other.

Under the above conditions we have only to suppose that similar particles to the lightest of those which fell upon the deck of the *Arabella* at 1,000 miles from Krakatoa were, under any atmospheric conditions we may imagine, suspended in the air, and the after-glow and other effects remain quite consistent with this suspension as far as optical principles carry us. At the same time we must conclude that lighter particles of like forms would remain in the atmosphere long after those of the density of the specimen shown on the table from the deck of the *Arabella* had fallen.

DISCUSSION.

The Rev. W. C. Ley in a letter to the Secretary said:—While hailing Mr. Stanley's admirable paper as marking a great advance in the investigation of the recent "after-glows" (or "upper-glows," as I should prefer to term them,) I wish to point out that there is one phenomenon persistently associated with these glows, and which scarcely seems to me to receive sufficient explanation from the present paper. Less attractive to the eye than the brilliant sunsets and sunrises, this phenomenon has received a comparatively small amount of attention, though it appears to have been noticed in nearly all those parts of the world from which reports of the glows have been received. I allude to the colour noticeable in the sky around the sun when the latter has been at or near his greatest altitude, on nearly all those days which were preceded or succeeded by the "upper-glow." The earthy pink colour or onion-tint which I speak of has, whenever visible, been distributed as a kind of ill-defined halo around the sun; and the radius of this halo when the halo was circular has been invariably 22°. On a few occasions the halo has been elliptical, extending at its greatest distance 25° from the sun. I would ask Mr. Stanley whether this fact does not indicate that the chromatic phenomena recently noticed have been due, partly at least, to ice spiculæ in very elevated portions of the atmosphere; these spiculæ being not only associated with particles of volcanic dust (perhaps of greater buoyancy than any which fell on board the *Arabella*), but having their state due to this dust, which would necessarily cause the condensation and congelation of such vapour as may exist at the elevation of the finest volcanic matter.

Mr. Ley further said—The glows still continue, though very interruptedly. On the 11th inst. there was a fine glow in West-north-west to North-west at 7.50 p.m. On the 12th the red halo was well marked in the total absence, as usual, of any visible upper cloud. After sunset there was again a distinct, but somewhat feeble upper-glow.

Mr. Abercromby said that if the sun-glows were caused by volcanic dust, Mr. Stanley's paper would be a very valuable contribution to our knowledge of the subject, as his observations gave a definite conception to the vague term—volcanic dust. With regard to the peculiar halo round the sun, he had asked Dr. Haughton to calculate whether volcanic dust would produce such a halo. He wished to know whether Mr. Stanley could give the index of refraction of the vitreous particles of volcanic dust.

Mr. Ladd remarked that the glows were very prominent last month between

Madeira and St. Vincent, Cape Verd Islands, and at St. Vincent. Sometimes there were two distinct glows, morning and evening, one commencing about an hour and a half before sunrise, about 30° above the horizon, and lasting a quarter of an hour or twenty minutes, and the other commencing about five or ten minutes after the disappearance of the first, about 60° above the horizon, extending almost and at times quite to the zenith and lasting till a quarter of an hour before sunrise; it then disappeared completely and the sun rose in a clear sky. The reverse took place after sunset. Between Madeira and the northern limit of the North-east Trade, about 22° N, the colours were varied, but in the region of the North-east Trade, where the atmosphere was dry, the colouring was monochromatic, usually beginning with a rose pink which sometimes deepened to light red.

Mr. RUSSELL was of opinion that the glows were the effect of reflection rather than refraction, the colours succeeding one another in the same order as in normal sunsets, which would not be the case if caused by refracting wedges.

Mr. LADD said that he remembered on one occasion the colours followed the order of the spectrum from greenish yellow to orange red, but above the orange red the colour was violet.

Mr. WHIPPLE said that Mr. Ley's idea of the halo being caused by ice particles was a very feasible one, as Mr. Stanley had stated that quantities of steam had been shot up from the volcano of Krakatoa. Steam did not exist at the height to which the dust had been projected, but snow crystals did, and so it was possible that the steam had become snow crystals, the volcanic dust forming the nucleus of the snow or ice particles in accordance with the fact, discovered by Mr. Aitken, that particles of solid matter are necessary for the formation of fog or cloud.

Mr. LECKY remarked that he had seen lately in some scientific periodical, that the principal meteorologists in America had given up the idea of the recent afterglows being occasioned by meteoric or volcanic dust, and had attributed them to a stratum of damp air: he considered this a much more likely cause, as he could not believe in such effects being produced by dust of any sort.

Mr. STANLEY could not say whether the sun-glows were caused by volcanic dust or not, all that he had done was to show that certain forms which prevailed in the dust were capable of producing such effects. He saw no objection to Mr. Ley's idea of ice particles being the cause of the halo, but he showed upon the black board that the glassy particles of the dust would produce precisely the same effects. As regards colour, red would be refracted at the smallest angle, but the other colours of the spectrum would be refracted at a greater angle from the same particles.

PROCEEDINGS AT THE MEETINGS OF THE SOCIETY.

MARCH 19th, 1884.

Ordinary Meeting.

ROBERT H. SCOTT, M.A., F.R.S., President, in the Chair.

WALTER BAILY, M.A., 176 Haverstock Hill, N.W.;
WILLIAM LUCK BLORE, Hill House, Sandown, Isle of Wight;
ALFRED LAWSON FORD, Old Park, Winchmore Hill, N.;
HUGO LEUPOLD, Assoc.M.Inst.C.E., Châlet Piccolo, Pontresina, Engadine;
ADOLPH FREDERICK LINDEMANN, F.R.A.S, Sidholm, Sidmouth; and
REV. EDWIN BRUNO SMITH, O.S.B., St. Augustine's Monastery, Ramsgate,
were balloted for and duly elected Fellows of the Society.

The following Paper was read:—

"BRIEF NOTES ON THE HISTORY OF THERMOMETERS." BY ROBERT H. SCOTT, M.A., F.R.S., President. (p. 167.)

The Meeting was then adjourned in order to afford the Fellows an opportunity of examining the following instruments which had been sent in for exhibition:—

FIFTH ANNUAL EXHIBITION OF INSTRUMENTS.

A. Graduation, &c., and Standard Thermometers.

1. **Dividing Engine,** by Perrault of Paris, screw having 51 threads to the inch, in use at the Kew Observatory for graduating Standard Thermometers since 1851. *Exhibited by* The Kew Committee.

2. **Frame for calibrating Standard Thermometer Tubes** after they have been graduated. *Exhibited by* The Kew Committee.

3. **Apparatus for Waxing Thermometer Tubes.** *Exhibited by* The Kew Committee.

4. **Apparatus for comparing Thermometers,** designed by Mr. Welsh, in 1851. *Exhibited by* The Kew Committee.

5. **Apparatus for Hall-marking Thermometers** verified at the Observatory. *Exhibited by* The Kew Committee.

6. **Apparatus for comparing Thermometers in melting Mercury.** *Exhibited by* The Kew Committee.

7. **Old Pattern Standard Thermometer.** *Exhibited by* G. J. Symons, F.R.S., F.R.Met.Soc.

8. **Various Standard Thermometers,** graduated at The Kew Observatory :—

(*a*) Range — 30° C. to 280° C. divided to 1°·0
(*b*) „ — 15 C. to 100 C. „ 0·5
(*c*) „ — 10 F. to 550 F. „ 0·1
(*d*)[1] „ — 40 F. to 210 F. „ 0·5

Exhibited by The Kew Committee.

9. **Standard Thermometer** presented by The Johns Hopkins University, U.S.A. *Exhibited by* The Kew Committee.

10. **Two Standard Thermometers** used in comparing Thermometers at the Society's Stations during Inspection. *Exhibited by the* Royal Meteorological Society.

11. **Calipers,** for measuring the external diameter of Thermometer Bulbs. *Exhibited by the* Royal Meteorological Society.

B. Maximum Thermometers.

12. **Rutherford's Mercurial Maximum and Spirit Minimum Thermometers** on the same frame. In the former, above the mercury, there is a piece of steel which is pushed on by that fluid, and retained in position by the friction of the tube ; it is adjusted by being brought down to the surface of the mercury by the attraction of a magnet. *Exhibited by the* Royal Meteorological Society.

13. **Phillips's Maximum Thermometer,** (1832), made by Prof. Phillips himself. *Exhibited by* J. J. Hicks, F.R.Met.Soc.

14. **Maximum Thermometer** in jacket. *Exhibited by* L. Casella, F.R.Met.Soc.

15. **Negretti and Zambra's Maximum Thermometer** (1852). The tube above the mercury is entirely free from air, and in the bend near the bulb is inserted and fixed with the blow pipe a small piece of solid glass, which acts as a valve, allowing the mercury to pass on one side of it in expanding, but on contraction causing the column of mercury in the tube to break off, so that the extremity shows the highest temperature that has been attained. *Exhibited by* Messrs. Negretti and Zambra.

[1] The above instrument was pointed off in melting Mercury.

16. **Hicks's Maximum Thermometer.** At a short distance from the bulb a small tube is carried from the side of the indicating tube; the bore of this short tube is larger than that of the indicating tube, and the action is as follows:—The Thermometer is set by the bulb end being held downwards to allow the short tube to become full. It is then placed in position horizontally, with the short tube uppermost. Any increase in temperature causes the column of mercury to rise in the ordinary tube, and upon a decrease taking place the top of the column remains at the maximum, and mercury in the short tube descends.
Exhibited by J. J. HICKS, F.R.Met.Soc.

C. MINIMUM THERMOMETERS.

17. **Negretti and Zambra's Mercurial Minimum Thermometer** (1855) with steel index. The Thermometer is suspended perpendicularly with the steel index resting on the surface of the mercurial column. As the mercury in the cylinder contracts from the effect of cold, that in the tube descends, and the index, of its own gravity, follows it; on the contrary, as the mercury expands and rises in the tube, it passes the index on one side, and in rising, exerts a lateral pressure on the needle, and forces it to one side of the tube, where it remains firmly fixed, leaving the upper point of the needle indicating the minimum temperature. In this thermometer, the reading is always from the upper point of the needle, and not from that of the mercury.
Exhibited by Messrs. NEGRETTI AND ZAMBRA.

18. **Negretti and Zambra's Mercurial Minimum Thermometer** (1862). A small vertical tube is connected with the indicating tube at right angles, about one inch from the bulb; in this tube is inserted a platinum plug. On a decrease of temperature the mercury falls in the large tube until it attains its lowest point; and on an increase of temperature, the mercury rises in the small tube, leaving the indicating column in the large tube registering the minimum temperature.
Exhibited by Messrs. NEGRETTI AND ZAMBRA.

19. **Casella's Mercurial Minimum Thermometer** (1861). At a short distance from the bulb a small bent tube with a large bore joins the indicating tube. At the upper end of this bent tube there is a flat glass diaphragm which is formed by the abrupt junction of a small chamber, the inlet to which is larger than the bore of the indicating tube. The result of this is, that on the thermometer being set, the contracting force of the mercury in cooling, withdraws the fluid in the indicating stem only, whilst on its expanding with heat, the long column does not move, the increased bulk of mercury finding an easier passage through the larger bore into the small pear-shaped chamber attached.
Exhibited by L. CASELLA, F.R.Met.Soc.

20. **Inverted Minimum Thermometer.**
Exhibited by Messrs. NEGRETTI AND ZAMBRA.

21. **Hicks's Mercurial Minimum Thermometer.**
Exhibited by J. J. HICKS, F.R.Met.Soc.

22. **Walferdin's Minimum Thermometer.**
Exhibited by THE KEW COMMITTEE.

D. COMBINED MAXIMUM AND MINIMUM THERMOMETERS.

23. **Six's Self-registering Maximum and Minimum Thermometer** (invented 1760). *Exhibited by* L. CASELLA, F.R.Met.Soc.

24. **Goolden's Electrical Six's Thermometer** (1882). The indices can be set at any desired range of temperature, and if the temperature either rises above or falls below these limits, a bell is sounded at any convenient distance from the instrument.
Exhibited by L. CASELLA, F.R.Met.Soc.

25. **Six's Self-registering Maximum and Minimum Thermometer,** with open top. (See *Quarterly Journal*, Vol. VI. p. 159.)
Exhibited by Messrs. NEGRETTI AND ZAMBRA.

26. **Hicks's Self-registering Mercurial Maximum and Minimum Thermometer.** *Exhibited by* J. J. HICKS, F.R.Met.Soc.

27. **Denton's Self-registering Maximum and Minimum Thermometer.** (See *Quarterly Journal*, Vol. II. p. 193.)
Exhibited by the ROYAL METEOROLOGICAL SOCIETY.

28. **Spitta's Mercurial Maximum and Minimum Registering Thermometer.** *Exhibited by* R. H. C. WILSON.

E. METALLIC THERMOMETERS.

29. **Johnson's Registering Metallic Marine Thermometer.**
Exhibited by THE METEOROLOGICAL COUNCIL.

30. **Hermann and Pfister's Metallic Maximum and Minimum Thermometer.** (*Repertorium für Meteorologie*, Vol. I. part 1, p. 7.)
Exhibited by THE METEOROLOGICAL COUNCIL.

31. **Metallic Thermograph** made by the late Mr. N. S. Heineken, in 1837.
Exhibited by the ROYAL METEOROLOGICAL SOCIETY.

32. **Direct Action Metallic Thermometer,** which consists of a compound bar of brass and steel rivetted together, and balanced on pivots in a vertical position. At the upper end of the bar is an adjustment ball of brass, and at the lower end, projecting at right angles on each side, are ball adjustments, by means of which the thermometric bar can be set to its fixed scale with reference to an ordinary mercurial thermometer attached below. *Exhibited by* C. COPPOCK, F.R.Met.Soc.

F. SELF-RECORDING THERMOMETERS.

33. **Whitehouse's Experimental Thermograph,** on Six's principle.
Exhibited by THE ROYAL METEOROLOGICAL SOCIETY.

34. **Thermograph Tubes** as used in the self-recording instruments of the Meteorological Council. (See *Report Meteorological Committee*, 1867, p. 28.) *Exhibited by* THE METEOROLOGICAL COUNCIL.

35. **Negretti and Zambra's Electrical Recording Thermometrical Apparatus.** This consists of twelve turnover Thermometers mounted on a stand; with a clock and a battery. Each thermometer is fixed in such a manner that it will fall over and become inverted on the release of a detent by the joint action of the clock and battery.
Exhibited by Messrs. NEGRETTI AND ZAMBRA.

36. **Travelling Thermograph,** by MM. Richard, Frères, Paris. Size 8½ ins. by 4¾ ins. by 6¾ ins.; weight 5½ lbs.
Exhibited by Hon. R. ABERCROMBY, F.R.Met.Soc.

G. SOLAR RADIATION THERMOMETERS.

37. **Black-bulb Solar Maximum Thermometer** *in vacuo.*
Exhibited by L. CASELLA, F.R.Met.Soc.

38. **Registering Maximum Thermometer,** with black bulb.
Exhibited by Messrs. NEGRETTI AND ZAMBRA.

39. **Negretti and Zambra's Black-bulb Thermometer,** *in vacuo*, with mercurial test gauge. *Exhibited by* Messrs. NEGRETTI AND ZAMBRA.

40. **Hicks' Black-bulb Solar Maximum Thermometer,** *in vacuo*, with platinum wires for testing the vacuum. *Exhibited by* J. J. HICKS, F.R.Met.Soc.

41. **Black bulb Solar Maximum Thermometer** in dry air.
Exhibited by G. J. SYMONS, F.R.S., F.R.Met.Soc.

42. **Experimental Solar-radiation Thermometers.** (See *Quarterly Journal*, Vol. X., p. 45.) *Exhibited by* THE KEW COMMITTEE.

43. **Bright-bulb Solar Maximum Thermometers,** *in vacuo*, showing old and new forms of mounts. *Exhibited by* L. CASELLA, F.R.Met.Soc.

44. **Frankland's Self-registering Differential Solar Thermometer,** for recording the maximum solar intensity during a day or any other period.
Exhibited by L. CASELLA, F.R.Met.Soc.

H. SEA THERMOMETERS.

45. **Johnson's Registering Metallic Marine Thermometer;** the indications of which are obtained by the varying expansion of brass and steel bars acting upon an index. *Exhibited by* Messrs. NEGRETTI AND ZAMBRA.

46. **Deep-sea Self-registering Thermometer** (1857), with protecting tube.
Exhibited by Messrs. NEGRETTI AND ZAMBRA.

47. **Miller-Casella Deep-sea Self-registering Thermometer.** The arrangement adopted for protecting the Thermometers from the effects of pressure, consists in enclosing the bulb in a glass tube. This outer tube is nearly filled with spirit, leaving a little space to allow a variation in bulk due to expansion. *Exhibited by* L. CASELLA, F.R.Met.Soc.

48. **Negretti and Zambra's Registering Deep-sea Thermometer.** This consists of a turnover Thermometer which has its bulb protected by an outer cylinder. The Thermometer is attached to a frame with a screw propeller. In its descent through the water the propeller is lifted out of gear and revolves freely on its axis ; but as soon as the apparatus is pulled upwards the propeller falls into gear and revolves in the contrary direction, turning the Thermometer over once, then becoming locked and immovable, and thus recording the temperature for the time of turning over. *Exhibited by* Messrs. NEGRETTI AND ZAMBRA.

49. **Negretti and Zambra's Improved Frame Deep-sea Thermometer,** with screw-fan and adjustment by means of which the Thermometer can be set to turn over at any required depth.
Exhibited by Messrs. NEGRETTI AND ZAMBRA.

50. **Negretti and Zambra's Marine Thermometer for shallow depths.** A turnover Thermometer is fitted into a wooden frame loaded with shot free to move from end to end of it. The instrument is buoyant in sea water. *Exhibited by* Messrs. NEGRETTI AND ZAMBRA.

51. **Set of six Thermometers,** in box, as supplied to ships.
Exhibited by THE METEOROLOGICAL COUNCIL.

52. **Maximum and Minimum Thermometers** for ship's chronometer rooms.
Exhibited by THE METEOROLOGICAL COUNCIL.

I. EARTH, WELL, &c., THERMOMETERS.

53. **Earth Thermometer** with pointed wooden protector.
Exhibited by L. CASELLA, F.R.Met.Soc.

54. **Symons's Earth Thermometers** to lower into iron pipes and record temperature at 1 ft. and 2 ft. below the surface.
Exhibited by L. CASELLA, F.R.Met.Soc.

55. **Phillips's Maximum Thermometer** divided to 0°·1, and reading to 0°·01. Protected by outer glass tube.
Exhibited by G. J. SYMONS, F.R.S., F.R.Met.Soc.

56. **Six's Thermometer,** used in the underground temperature experiments at Kentish Town, at a depth of 1,200 ft. below the surface.
Exhibited by G. J. SYMONS, F.R.S., F.R.Met.Soc.

57. **Well Thermometer** in copper case.
Exhibited by L. CASELLA, F.R.Met.Soc.

58. **Slow Action Thermometer** for ascertaining the temperature of the earth or springs. *Exhibited by* Messrs. NEGRETTI AND ZAMBRA.

J. THERMOMETERS USED FOR SPECIAL PURPOSES.

59. **Appold's Hygrometer.** *Exhibited by* THE ROYAL SOCIETY.

60. **An Air Thermometer poised on Centres,** and having small cisterns of mercury at either end. The mercury in the cisterns is moved by the expansion or contraction of the confined air more or less to either end, and so upsets the balance of the instrument as to join up an electrical circuit, and gives warnings of changes of temperature by ringing a bell.
Exhibited by G. E. PRITCHETT.

61. **Wedgewood's Original Pyrometer.** *Exhibited by* THE ROYAL SOCIETY.

62. **Negretti and Zambra's Turnover Thermometer.** This in shape is like a siphon with parallel legs, having a continuous communication. The scale with the Thermometer is pivoted on a centre, and attached in a perpendicular position to a simple clock movement, by which, at any desired moment, the instrument turns once upon its centre, first bulb uppermost, and afterwards bulb downwards. This causes the mercury, which was in the left-hand column, first to pass into the dilated siphon bend at the top, and thence into the right-hand tube, where it remains, indicating on a graduated scale the exact temperature at the time it was turned over. *Exhibited by* Messrs. NEGRETTI AND ZAMBRA.

63. **Negretti and Zambra's Turnover Dry and Wet Bulb Thermometer.**
Exhibited by Messrs. NEGRETTI AND ZAMBRA.

64. **Thirty-five Thermometers with constant Zero,** in case, together with certificates of verification. *Exhibited by* S. G. DENTON, F.R.Met.Soc.

65. **Set of Thermometers with constant Zero for Meteorological purposes;** consisting of dry and wet, maximum, minimum, black bulb *in vacuo*, and grass minimum; also two Standard Thermometers graduated to 140° and 220°. All these thermometers have the Kew corrections for scale errors etched at their respective places on the tubes.
Exhibited by S. G. DENTON, F.R.Met.Soc.

66. **Thermometre Fronde,** in case for pocket. This thermometer is arranged to be rapidly swung several times round the head by means of a silk cord, when it will be found to show almost the true temperature of the air. *Exhibited by* L. CASELLA, F.R.Met.Soc.

67. **Original Centigrade Thermometer by Gay-Lussac.**
Exhibited by G. J. SYMONS, F.R.S., F.R.Met.Soc.

68. **Maximum and Minimum Thermometers used in Sir J. C. Ross's Antarctic Expedition, 1839-43.**
Exhibited by J. J. HICKS, F.R.Met.Soc.

69. **Spirit Thermometer** graduated by Welsh for Belcher's Arctic Expedition of 1852. (*Roy. Soc. Proc.* VI. p. 183.)
Exhibited by THE KEW COMMITTEE.

70. **Spirit Thermometer** used in H.M.S. *Enterprise*, in Collinson's Arctic Expedition, with true and maker's scales, showing difference of 28° at —70°. *Exhibited by* THE KEW COMMITTEE.

71. **Thermometer** for Sledging Expeditions in the Arctic Regions.
Exhibited by THE METEOROLOGICAL COUNCIL.

72. **Two Low Range Thermometers:** (1) Mercurial, Newman No. 232, (2) Spirit, Newman No. 13.
Exhibited by THE METEOROLOGICAL COUNCIL.

73. **Wide Range Minimum Thermometer,** graduated from—100° to + 115°.
Exhibited by G. J. SYMONS, F.R.S., F.R.Met.Soc.

74. **Five Fluctuation Thermometers** of various patterns. This Thermometer, in which advantage has been taken of the difference of capillary force and friction in two tubes of different capacity connected with the same bulb, was devised by Prof. Balfour Stewart, to measure the sum of the fluctuations of temperature. (See *Roy. Soc. Proc.* VIII. 1856-57, pp. 195-201.) *Exhibited by* THE KEW COMMITTEE.

75. **Open Scale Thermometers** used for Experiments:—(1). By Prof. Balfour Stewart, to repeat Prof. Forbes's Experiments as to the temperature of interior of a block of melting ice. (Stewart on *Heat*, p. 95.) (2) By Mr. Whipple to determine the effect of variation of Atmospheric pressure upon the melting point of ice. (3) To repeat Dr. Guthrie's experiments as to the variability of melting point; and (4) To compare melting points of Snow, Block Ice, Rough Ice, and Distilled Water Ice.
Exhibited by THE KEW COMMITTEE.

76. **Regnault's Apparatus,** used at the Kew Observatory, for determining the Boiling Point. *Exhibited by* THE KEW COMMITTEE.

77. **Welsh's Portable Form** of the same.
Exhibited by THE KEW COMMITTEE.

78. **Arbitrary Scale Standard Thermometer, by Welsh.** (*Roy. Soc. Proc.* VI. p. 178.) *Exhibited by* THE KEW COMMITTEE.

79. **Spirit Thermometer used by Prof. Faraday.**
Exhibited by THE KEW COMMITTEE.

K. THERMOMETERS WITH VARIOUS FORMS OF BULBS, SCALES, &c.

80. **Thermometers with Different Forms of Bulbs**—Cylindrical, Flat, Hook, and Gridiron. *Exhibited by* L. CASELLA, F.R.Met.Soc.

81. **Set of Fourteen Delicate and other Thermometers** used in experiments on the sensitiveness of Thermometers.
Exhibited by G. J. SYMONS, F.R.S., F.R.Met.Soc.

82. **Bottle Bulb Mercurial Thermometer,** designed by Beckley.
Exhibited by THE KEW COMMITTEE.

83. **Hicks's Hollow Bottle Bulb Minimum Thermometer.**
Exhibited by G. J. SYMONS, F.R.S., F.R.Met.Soc.

84. **Hicks's Hollow Cylinder Minimum Thermometer.**
Exhibited by J. J. HICKS, F.R.Met.Soc.

85. **Bifurcated Minimum Thermometer,** mounted on Ebonite.
Exhibited by L. CASELLA, F.R.Met.Soc.

86. **Extra Sensitive Straight-bulb Mercurial Thermometer** for Observations in Balloons. *Exhibited by* L. CASELLA, F.R.Met.Soc.

87. **Thermometers with External Protecting Tubes.**
Exhibited by MESSRS. NEGRETTI AND ZAMBRA.

88. **Hicks's Grass Minimum Thermometer,** with ground joint to exclude moisture. *Exhibited by* J. J. HICKS, F.R.Met.Soc.

89. **Set of Thermometers with Glass Shields** over the divisions and figures, hermetically sealed at both ends:—Dry and Wet Bulbs, Maximum, Minimum, and Grass Minimum.
Exhibited by J. J. HICKS, F.R.Met.Soc.

90. **Thermometers with Black Glass Bulbs.** Minimum in Jacket, Mercurial Minimum in Jacket, and Maximum on Ebony.
Exhibited by L. CASELLA, F.R.Met.Soc.

91. **Greenwood's Fluorescent Thermometer.**
Exhibited by G. J. SYMONS, F.R.S., F.R.Met.Soc.

92. **Pocket Thermometer with Fahrenheit and Centigrade Scales** in ivory case. *Exhibited by* G. J. SYMONS, F.R.S., F.R.Met.Soc.

93. **Thermometer with Fahrenheit, Centigrade and Reaumur Scales.**
Exhibited by G. J. SYMONS, F.R.S., F.R.Met.Soc.

L. MISCELLANEOUS THERMOMETERS.

94. **Dry and Wet Bulb Thermometers.**
Exhibited by L. CASELLA, F.R.Met.Soc.

95. **Portable Dry and Wet Bulb Thermometers,** in Pocket Case for Travellers.
Exhibited by L. CASELLA, F.R.Met.Soc.

96. **Maximum and Minimum Thermometers,** Livingstone Pattern, in Pocket case for Travellers. *Exhibited by* L. CASELLA, F.R.Met.Soc.

97. **Bath Thermometer** in japanned case.
Exhibited by G. J. SYMONS, F.R.S., F.R.Met.Soc.

98. **German Thermometer.**
Exhibited by THE METEOROLOGICAL COUNCIL.

99. **Mountain Thermometers** constructed by Welsh's Method. (*Brit. Assoc. Report*, 1856, p. 9). *Exhibited by* THE KEW COMMITTEE.

100. **Hypsometer,** for measuring height of mountains by the temperature of boiling water. *Exhibited by* L. CASELLA, F.R.Met.Soc.

101. **Improved Legible Thermometer** for indoor purposes, with a range of scale from 35° to 85°. The tube is filled with a black fluid, and the dark lines and figures at 50°, 60° and 70°, are brought slightly over the edge to allow the Thermometer to be read sideways. The bulb, which is a long cylindrical one, passes up at the back of the scale.
Exhibited by R. H. C. WILSON.

102. **Clinical Thermometers**:—(1) With the front made in the form of a lens to magnify the column of mercury ten times. (2) ditto with hermetically sealed shield over the divisions and figures.
Exhibited by J. J. HICKS, F.R.Met.Soc.

103. **Set of Cheap Thermometers,** ranging in price from 2½d. to 10½d.
Exhibited by G. J. SYMONS, F.R.S., F.R.Met.Soc.

M. THERMOMETER SCREENS.

104. **Stevenson Thermometer Screen.**
Exhibited by L. CASELLA, F.R.Met.Soc.

105. **Modified Stevenson Thermometer Screen** as recommended for use at the Society's Stations.
Exhibited by THE ROYAL METEOROLOGICAL SOCIETY.

106. **Thermometer Screen for use on board Ship.**
Exhibited by THE METEOROLOGICAL COUNCIL.

N. NEW INSTRUMENTS.

107. **Christensen's Electric "Storm Signal" Barometer.**—This Instrument is constructed in order to give notice of any rapid fall of the barometer. It is a siphon barometer, and as the mercury rises in the short leg of the tube, it comes in contact with an adjustable metallic point, and by completing an electric circuit, sets an electric bell ringing.
A similar contrivance as fitted to Aneroids, is also exhibited.
Exhibited by Messrs. CHRISTENSEN & CO.

108. **A poised Barometer** adapted to register variations of atmospheric pressure at any distance away from it by electrical appliances in connection with it: the record being effected by a point at the end of the tube striking periodically on an index-plate.
Exhibited by G. E. PRITCHETT.

109. **Mining and Surveying Aneroid,** reading to one foot. The vernier scale is moved by rack-work, and a lens on the outer circumference of the instrument facilitates the reading of minute quantities.
Exhibited by Messrs. J. DAVIS & SON.

110. **Lowne's Short Leg Mercurial Barometer.**
Exhibited by THE METEOROLOGICAL COUNCIL.

111. **Differential Barometer.** This has an elastic corrugated chamber similar to the vacuum box of an aneroid, and connected with this is a glass tube with fine bore. The chamber is filled with a coloured fluid which is forced up the tube by the varying pressure of the atmosphere. At the top end of the tube is a bulb, and by careful manipulation the air contained in it is made to counteract the effect of the expansion of the fluid in the chamber, thus rendering the barometer compensated for temperature. *Exhibited by* R. H. C. WILSON.

112. **Baily's Integrating Anemometer.**—This instrument resolves the velocity of the wind in the directions of the two adjacent cardinal points, and gives the time-integral for each of the cardinal points separately. There is a horizontal plate in which are four slits forming arms of a cross directed towards the cardinal points. A slider carrying beneath it a wheel, whose plane is perpendicular to the North and South slits, moves in those slits, and a similar slider moves in the East and West slits. The sliders are connected by a bar. A rod to be connected with a vane descends over the centre of the cross, and an arm from the rod holds a pin in the centre of the bar. This arm is kept in the direction of the wind. The wheels rest on a horizontal disk, whose centre is beneath the centre of the cross, and which is to be revolved by Robinson's cups. The result is that each wheel revolves at a rate proportional to the resolved part of the wind in the direction of the corresponding slit. At each revolution of a wheel an electric current is made and broken, and an electric counter, with an indicator for each of the cardinal points, gives the reading of the instrument.
Exhibited by W. BAILY, M.A.

113. **Air Meter with electrical appliance,** by means of which the velocity of air passing, e.g. in a mine or elsewhere, can be ascertained at any distance away from it. *Exhibited by* G. E. PRITCHETT.

114. **Universal Sunshine Recorder,** with Prof. Stokes's zodiacal frame.
Exhibited by C. COPPOCK, F.R.Met.Soc.

115. **Whipple-Casella Sunshine Recorder.**—The instrument is universal, having divided latitude and diurnal circles, and thus can be easily set for any locality, and for any day in the year.
Exhibited by L. CASELLA, F.R.Met.Soc.

116. **New Form of Cloud Mirror** for rapidly determining the direction from which clouds are travelling. *Exhibited by* W. F. CORY, F.R.Met.Soc.

117. **Fog Gauge, and Photographs,** showing it in position. (See *Symons's Monthly Meteorological Magazine* for 1883, p. 48.)
Exhibited by G. W. ORMEROD, F.R.Met.Soc.

118. **Buchanan's Piezometer** for Deep Sea soundings.
Exhibited by L. CASELLA, F.R Met.Soc.

O. DRAWINGS, PHOTOGRAPHS, &c.

119. **Description with Engraving of Galton's Thermometer Testing Apparatus** now employed at the Kew Observatory.
Exhibited by THE KEW COMMITTEE.

120. **Photographs,** showing the different forms of Thermometer Screens used in the Strathfield Turgiss Experiments, 1869.
Exhibited by G. J. SYMONS, F.R.S., F.R.Met.Soc

121. **Photographs of Thermometer Screens** at the Kew Observatory.— Thermograph; Wild; Stevenson; and De La Rue.
Exhibited by THE KEW COMMITTEE

122. **Set of Photographs of the Royal Observatory, Greenwich.** (1871.)
Exhibited by W. MARRIOTT, F.R.Met.Soc

123. **Set of Seven Photographs** and Map, showing the position of the Observatory on the Pic du Midi de Bagnères (9,439 ft. above sea level) and the surrounding country.
Exhibited by G. J. SYMONS, F.R.S., F.R.Met.Soc

124. **Thermograms** obtained at the Kew Observatory showing (*a*) Sudden fall of 12°; (*b*) Sudden fall of 12°; (*c*) Minimum daily range, 2°·5; (*d*) Maximum daily range, 27°·0 *Exhibited by* THE KEW COMMITTEE

125. **Comparative Curves from the Richard and Kew Thermographs.**
Exhibited by THE KEW COMMITTEE

126. **Plate showing fifteen different Scales of Thermometers,** from Dr. G. Martine's Essays on the construction and graduation of thermometers 1792. *Exhibited by* G. J. SYMONS, F.R.S., F.R.Met.Soc

127. **Fifty coloured Sketches of Skies, Clouds, &c.,** taken during 1883 and 1884. Thirty-six of these drawings represent the chromatic effects of the "recent celestial phenomena" foreglows, afterglows, &c. of November and December, 1883.
Exhibited by J. S. DYASON, F.R.Met.Soc

128. **Three Sketches of the After-Glow** in November, 1883, by Miss LECKY.
Exhibited by R. J. LECKY, F.R.Met.Soc

129. **Sunshine Diagrams,** 1882 and 1883, for Aspley Guise.
Exhibited by R. J. LECKY, F.R.Met.Soc

130. **Diagram of Diurnal Inequalities** of the Barometer at Twenty-three places in various parts of the world
Exhibited by F. A. BELLAMY, F.R.Met.Soc

131. **Diagram** for showing daily Meteorological changes for several years.
Exhibited by G. BARTON

APRIL 16th, 1884.

Ordinary Meeting.

JOHN KNOX LAUGHTON, M.A., F.R.A.S., Vice-President, in the Chair.

JAMES YOUNG DAVIDSON, Nagpur, Central Provinces, India; and
THOMAS WRIGHT, Egremont Villa, Leicester Road, New Barnet,
were balloted for and duly elected Fellows of the Society.

The following Papers were read:—

"ON THE ORIGIN AND COURSE OF THE SQUALL WHICH CAPSIZED H.M.S "EURYDICE," MARCH 24th, 1878. By the Hon. RALPH ABERCROMBY F.R.Met.Soc. (p. 172.)

"WATERSPOUTS AND THEIR FORMATION." By CAPT. J. W. C. MARTYR.

ON a coasting voyage between East London and Port Elizabeth—ports in the Cape Colony—a Waterspout was observed from its very commencement to it

final collapse, and in the following lines I have endeavoured to give a description of it.

The whole phenomena occurred so close to the ship that I can vouch for the accuracy and minuteness of what I saw, and the results written down a few minutes after, while it still remained vivid in my mind.

About 5 p.m. on December 7th, 1883, off Padrone Point, which is about thirty-five miles to the East and North of Port Elizabeth, while keeping the morning watch on the bridge of the *Spartan*, I observed an unusual agitation on the sea, about three points on the starboard bow, and not more than half-a-mile off, over which hung a very heavy and black *nimbus*, from which heavy rain appeared to be descending, but which, through my binocular, I saw was ascending in spiral curves revolving from right to left to the cloud. The influence of this whirlwind extended over a circle, the diameter of which was about 100 yards, that is, when it was about a quarter of a mile off, and about eight miles from the land by which I judged its size. The sea seemed to heap itself up in the centre, and the circumference of the circle, in which the sea continued to be drawn up in much heavier spray, to contract. The phenomena at this time being right abeam and only about 200 yards off, were seen very plainly. The uprising spray got now so dense that it appeared more like a column. The cloud right above seemed to me, and in the only way which I can describe it, to resemble a handkerchief full of water, held by the four corners, the waters forcing the middle down, but with a heaving sort of motion, as if the handkerchief was being stretched and having its centre lifted. Towards this centre now the sea column rose, and suddenly joined at the moment when the cloud seemed receding from it, and it formed a Waterspout. It only lasted two minutes, when it collapsed. I had been watching this wonderful sight so intensely that I seemed to feel and see how it was made.

"THE WEATHER FORECASTS FOR OCTOBER, NOVEMBER AND DECEMBER, 1883." By CUTHBERT E. PEEK, M.A., F.R.Met.Soc. (p. 183.)

"ON CERTAIN EFFECTS WHICH MAY HAVE BEEN PRODUCED IN THE ATMOSPHERE BY FLOATING PARTICLES OF VOLCANIC MATTER FROM THE ERUPTIONS OF KRAKATOA AND MOUNT ST. AUGUSTIN." By WILLIAM F. STANLEY, F.R.Met.Soc., F.G.S. (p. 187.)

CORRESPONDENCE AND NOTES.

ATLANTIC WEATHER MAPS.

An early suggestion of Atlantic Weather Maps is conveyed in the following extract from a letter from Sir Francis Beaufort to Sir Edward (then Capt.) Sabine :—

"Admiralty, September 11th, 1833.

"DEAR SIR,

"The sudden and large change in the diurnal variation which you mention is a curious circumstance,—and not less so that our last disastrous storm should not have extended to Limerick. It would be very interesting to trace the limits and the curvilinear course of some of our gales.

"In the dreadful storm of 1826 (I think), which was South-west in the Channel, and lined the coast between Start Point and Land's End with thirty-three wrecks, I was at Holyhead, where the wind was all that night at North-east, and blowing equally strong.

"I have often intended, if I could ever have found a week's leisure, to take all the journals that could be found in the Office for some years of the last war, when the seas were covered with our ships, and make a series of charts showing the direction of the wind across the Atlantic, &c. for certain hours through the day.

* * * * * *

"Yours very truly,

"F. BEAUFORT."

Rainfall in South Australia.

Mr. C. Todd, in his Report for 1881, gives the following account of the distribution of rain over the whole of the colony of South Australia :—

"The tropical rains on the North coast prevail during the summer months, commencing generally towards the end of October or beginning of November, and lasting until April, little or none falling during the intermediate months. These tropical rains extend more or less across the interior down to, or even south of, the Peak (lat. 28°), but fall off considerably south of Daly Waters (lat. 16° 15′); this, however, varies greatly in different years, according to the force and Southerly dip of the North-west monsoon. In some cases heavy thunderstorms and torrential rain extend over nearly the whole of the interior, and in other years the rainfall is heavy for only a few hundred miles from the North coast, and the country, especially south of the Tropics, down even to the head of Spencer's Gulf, is exposed to long and severe drought. On the other hand, the winter rains occasionally extend well up into the interior, sometimes reaching or passing the centre of the continent. This, perhaps, is more especially the case when the centre of a cyclonic disturbance passes to the North of Adelaide from West to East; and also when cyclonic disturbances in Queensland, or on the East coast, have their western quadrant extending well into the central regions of the continent, and the northern pastoral districts of South Australia. But most of our disturbances have their centre South of the continent, their path being roughly parallel to the coast-line, so that as a rule our winter rains thin off and become uncertain about 100 miles North of the head of Spencer's Gulf, and are heavy North of the gulf only, along or near the Flinders Range. The area of minimum rainfall extends from the Great Australian Bight to Port Augusta, at the head of Spencer's Gulf, northwards up Lake Torrens and Lake Eyre, and again over the plains to the East of the Flinders Range, up to about lat. 25°, reaching on either side to within perhaps a few hundred miles of the East and West coasts; but the rains on the East coast penetrate farther inland. All south of this, and for some distance northwards along and in the immediate neighbourhood of the Flinders Range, we usually have good winter rains, but uncertain summer rains—the latter being heavier and more frequent over the northern limits of this region, where they bear a large ratio to the total fall during the year, thus—

"At Warcowie the mean annual rainfall from ten years' records is 12·649 ins., of which 4·942 ins. fall during the five summer months, and 7·707 ins. in the winter and spring, or wheat-growing months.

"At Mattawarrungalla the mean annual rainfall from fourteen years' records is 11·514 ins., of which 4·961 ins. fall during the five summer months, and 6·553 ins. during the remaining seven months.

"At Clare, the annual rainfall is 24·496 ins., of which 5·589 ins. fall in the summer, and 18·907 ins. in the winter and spring.

"On the Adelaide Plains (represented by Adelaide), with an average rainfall of 20·439 ins., 4·659 ins. falls in summer and 15·780 ins. are accounted for in the wheat-growing months.

"On the Mount Lofty Range we have at Gumeracha a mean annual rainfall of 32·815 ins., of which the summer contributes 6·498 ins., leaving 26·317 ins. for the wheat-growing months; and at Mount Barker, where the annual rainfall, taking twenty-one years, is 29·423 ins., the summer fall is 5·941 ins., and the winter 23·482 ins.

"In the South-east the greatest rainfall is around Mount Gambier, where the average from twenty-one years' records is 31·671 ins., of which 7·882 ins. fall in the five summer months, and 23·789 ins. in the winter and spring months. North of Mount Gambier the rainfall gradually diminishes, but is fairly plentiful, and the winter rains up to beyond Border Town are between seven and eight tenths of the fall for the whole year.

"East of the Mount Lofty Ranges and along the valley of the Murray the rainfall diminishes, and the winter rains, especially along the Murray, are scant. Thus at Blanchetown the rainfall is 12·840 ins., of which 4·445 ins. falls in the summer, and 8·395 ins. in the winter; and at Wentworth the fall is 12·977 ins., of which 5·268 ins. represents the summer rains, and 7·709 ins. the winter—or less than six-tenths of the year's rainfall.

"These are facts which deserve careful consideration in extending the area of agriculture."

RECENT PUBLICATIONS.

A BAROMETER MANUAL FOR THE USE OF SEAMEN. Issued by the Authority of the Meteorological Council. Official, No. 61. 8vo. 1884. 41 pp. and 2 plates.

This work gives a description of the barometer, with instructions for its management, method of reading, &c. The distribution of mean barometric pressure over the globe is shown by isobaric charts for January and July. After a brief notice of the periodical and non-periodical variations of pressure, and the causes which determine the force and direction of the wind, an account is given of the prevailing winds at various seasons over different parts of the globe, the winds and storms of the Temperate zones, and Tropical storms. The work concludes with some practical rules for seamen in tropical cyclones.

AMERICAN JOURNAL OF SCIENCE. Vol. XXVIII. July 1884. 8vo.

Contains:—Contributions to Meteorology, by Prof. E. Loomis. Twentieth Paper (29 pp. and 2 plates). In this article the author deals with the question of the reduction of barometric observations to sea-level. Having reduced to sea-level by the various formulæ the observations made at the summit and base of several high mountains under different conditions of weather, Prof. Loomis concludes that it is utterly hopeless to discover a formula which shall exactly represent the barometric reduction to sea-level at all pressures and temperatures, unless the formula takes account of these dissimilar movements in the upper and lower strata of the atmosphere; and since these movements are greatly modified by the obstruction of the mountains upon which the observations are made, and therefore vary with the locality, such an attempt seems a hopeless undertaking.

ANNUAIRE DE LA SOCIÉTÉ MÉTÉOROLOGIQUE DE FRANCE. Vol. XXXI. November-December 1883. 4to.

Contains:—Note sur l'annonce des crues de l'Epte par les observations de la pluie à Gournay et à Forges, par M. Goupil (3 pp.).—Observations faites à Marly-le-Roi, de Mai à fin Septembre 1883, sur les courants telluriques, par G. Raymond (13 pp.).—Note sur le mistral, par P. Cœurdevache (2 pp.).—Sur la variation diurne de la force du vent, par E. Hamberg (5 pp.).

BEITRÄGE ZUR PHÄNOLOGIE. Von Dr. EGON IHNE und Dr. HERMANN HOFFMANN. 8vo. 178 pp. 1884.

This work is divided into two parts. The first part gives a detailed list of various publications dealing with the flowering of plants; the second, a list of observations on special plants (some 40 species) taken during the years 1877 to 1882 at various stations, and contributed to the Professors by the Observers. The first part was formed by Professor Ihne, when studying the subject with a view to forming charts of plant-flowering for Europe generally. The list is arranged under the countries of Europe; and there is also given a short account of the phenological work done, and the publications issued in each country. The notices of observations are scattered over a variety of works, and the author numbers 196, consisting of Reports of Botanical Societies and similar publications. Great trouble has been taken to make this list complete, but from the fact that some of the notices have been extracted from works the titles of which would not be any guide to their containing such notices, it is very probable that the list may hereafter be added to. At the same time, it must be admitted that the work supplies a very great want, and will be most useful to those who wish to work up the subject from the original sources. The index consists of (1) a list of all stations at which observations have been taken, the stations being arranged alphabetically under the countries in which they occur, and are 1926 in number; and (2) an alphabetical list of all the above-mentioned stations, with the years during which observations have been taken there, as well as a reference to the works in which they are published.

The second part of the work contains the records of the observations on the plants given in the list, which has been extensively published in this country. The list differs essentially from that issued by the Royal Meteorological Society in containing many cultivated plants, especially trees.

...ETIN DE LA ACADEMIA NACIONAL DE CIENCIAS EN CORDOBA (Republica Argentina). Tomo VI. Entrega 1a. 8vo. 1884.

This part is entirely devoted to a Paper by Oscar Doering on the diurnal ...riations of Temperature at Bahia Blanca (156 pp.). The discussion is based ... the observations made during the twenty-one years 1860-1880, by Sr. D. ...elipe Caronti, and published in Tomo II. of the *Anales de la Oficina Meteorológica ...rgentina.* The author discusses the daily range of temperature during the ...bove period, and gives the mean result as 8°·0. Tables are given showing the daily increase or decrease for each month, and also the connection between the daily changes of temperature with those of pressure, moisture, cloudiness, and wind-force, with the probability per 1,000 cases of the rise or fall of temperature being accompanied by changes in the other meteorological conditions.

BOLETIN DE LA SOCIEDAD GEOGRÁFICA DE MADRID. Vol. XVI. Nos. 3-4. March and April 1884. 8vo.

Contains:—Reseña Geológica de la Provincia de Valencia, por D. Juan Vilanova (22 pp.). Chapter III. is devoted to the climatology of the Province, and the author gives tables of the results of meteorological observations made at Castellon during the years 1882 and 1883. The following are the chief results for each year:—

	Barometric Pressure. ins.	Temperature Highest. °	Lowest. °	Mean. °	Rainfall. ins.	Number of Rainy Days.
1882	30·066	100·6	36·7	67·8	75·62	64
1883	29·977	97·7	36·5	61·7	18·06	53

CIEL ET TERRE, REVUE POPULAIRE D'ASTRONOMIE, DE MÉTÉOROLOGIE, ET DE PHYSIQUE DU GLOBE. Vol. V., Nos. 5-10. May to July 1884. 8vo.

The principal meteorological articles are:—Peut-on provoquer la chute de la pluie (11 pp.).—L'Aurore et le Crépuscule, par S. Lagrange (12 pp.).—L'Arc-en-Ciel (7 pp.).—Les lueurs crépusculaires, par L. Mahillon (5 pp.).—Le Climat du Congo, par A. Von Danckelman (15 pp. and plate).

COMMUNICATIONS FROM THE INTERNATIONAL POLAR COMMISSION. Fifth Part. 4to. 1884.

The chief Paper in this part is Dr. Ekholm's report on the Swedish Expedition to Spitzbergen, 1882-83. Meteorological observations were made at every hour from August 15th, 1882, to August 23rd, 1883. The mean results were:—barometric pressure 29·555 ins.; temperature 20°·8; amount of cloud 6·9; total rainfall 7·23 ins.; nnmber of rainy days 124.

DAS WETTER. METEOROLOGISCHE MONATSCHRIFT FÜR GEBILDETE ALLER STÄNDE. Herausgegeben von Dr. R. ASSMANN. No. 3, June 1884. 8vo.

Contains:—Ueber locale Wetterprognose, von Prof. R. Börnstein (8 pp.).—Zur Erklärung des braunrothen Ringes um die Sonne, von Prof. Kiessling (4 pp.).—Uebersicht über die Witterung des März 1884 in Central-Europa (3 pp.).

HOW TO FORETELL THE WEATHER WITH THE POCKET SPECTROSCOPE. By F. W. CORY, M.R.C.S., F.R.Met.Soc. 8vo. 86 pp. 1884.

The author begins by giving an account of the various classes of hygrometers, and then describes the "Rainband Spectroscope," and explains how it should be used. The principal rainband is situated on the red side of the D lines, involving them, and at times increasing or decreasing in intensity, and approaching or receding from the C line according to the nearness or quantity of rain. In spectroscopes of small dispersion it exhibits itself as a dark shading; in larger instruments this band will be split up into a quantity of fine black lines. This band has great variations in its appearance—at one time being narrow and condensed, or broad and extended; at other times almost uniform in darkness, or rapidly shading off, or exhibiting itself as two dark lines to the red side of D, with one bright interval frequently between them and another in the space between them, the more refrangible towards the green and D. When they are

strong and well-marked, they may certainly be taken as indicative of heavy rain. A thickness and darkness about the D lines alone must not be considered as a reliable rain prognostic.

JOURNAL AND PROCEEDINGS OF THE ROYAL SOCIETY OF NEW SOUTH WALES. 1882, Vol. XVI. 8vo. 1883.

Contains:—Anniversary Address, by H. C. Russell, President (30 pp.). In the latter part of his Address, Mr. Russell introduces some considerations towards forming a correct opinion as to the possibility of producing rain artificially.—Tropical Rains, by H. C. Russell (8 pp. and 6 maps). This is an investigation into the very heavy rainfall which occurred in New South Wales in February 1882.

METEOROLOGICAL OBSERVATIONS MADE AT THE ADELAIDE OBSERVATORY AND OTHER PLACES IN SOUTH AUSTRALIA AND THE NORTHERN TERRITORY DURING THE YEAR 1881, under the direction of CHARLES TODD, C.M.G., F.R.A.S. Folio. 850 pp. 1884.

In addition to the usual interesting information given in these annual reports, this volume contains an account of the proceedings of the second Meteorological Conference held at Melbourne in April 1881, at which several valuable reports were presented, and resolutions adopted for securing uniformity of observation, &c. throughout Australia and New Zealand.

PROCEEDINGS OF THE MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY. Vol. XXII. Session 1882-83. 8vo. 1883.

Contains:—On a fresh determination of the freezing point in a sensitive thermometer, by Dr. J. P. Joule (1 p.).—Remarks on the simultaneous variations of the barometer recorded by the late John Allan Broun, by Prof. B. Stewart (2 pp.).—Observations made at St. Moritz in the winter 1882-3, by A. W. Waters (17 pp.).

PROCEEDINGS OF THE ROYAL SOCIETY. Vol. XXXVI. Nos. 280-281. 1884. 8vo.

Contains:—On a method of tracing periodicities in a series of observations when the periods are unknown, by V. N. Nene (43 pp. and plate). This is an investigation of a new method which will enable us to find out the period of an unknown inequality, and thence the inequality itself, from a series of observations—such as magnetical, meteorological, or astronomical—when they are of a periodic nature.

REPORT OF THE FIFTY-THIRD MEETING OF THE BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE, held at Southport in September 1883. 8vo. 1884.

Among the meteorological papers read at this Meeting and printed in abstract in the Report were the following:—Report of the Committee on underground temperature (4 pp.).—On the heat of the sunshine at the Kew Observatory, as registered by Campbell's method, by Profs. H. E. Roscoe and B. Stewart (4 pp.).—Description of a marine anemometer by Dr. W. G. Black (1 p.).—On a method for measuring the height of the Clouds, by Prof. Lüroth (1 p.).—Report on the circulation of the underground waters in the permeable formations of England, and the quality and quantity of the waters supplied to various towns and districts from these formations (13 pp.).—On the influence of barometric pressure on the discharge of water from springs, by Baldwin Latham (1 p.).

SIGNAL SERVICE NOTES, No. IX. WEATHER PROVERBS. Prepared by LIEUT. H. H. C. DUNWOODY. 8vo. 1883. 148 pp. and map.

This contains an interesting collection of popular weather proverbs, prognostics, &c. in use in the United States, and also among the Zuni Indians of New Mexico. Messrs. Abercromby and Marriott's paper, "Popular Weather Prognostics," read before this Society on December 20th, 1882, is printed in full, together with the discussion. The author gives the instrumental and other local indications of approaching storms, compiled from reports made to the Chief-

Signal Officer by observers of the Signal Service, U.S.A., and also the quadrants from which winds are most likely to be followed by rain or snow in the several districts of the United States.

SYMONS'S MONTHLY METEOROLOGICAL MAGAZINE. Vol. XIX. Nos. 220-222. May to July 1884. 8vo.

The chief articles are:—The Great English Earthquake (14 pp. and two maps). This is an account of the earthquake which occurred near Colchester at 9.17 a.m. on April 22nd.—Easter at the Sorbonne (4 pp.).—A heavy Indian rainfall and its result (1 p.).—On the absence of dew beneath a cloudless nocturnal sky, by C. Tomlinson, F.R.S. (2 pp.).—On hygrometry, by J. Jamin (4 pp.).—Severe thunderstorms, by the Rev. W. C. Ley (2 pp.).

THE ALPINE WINTER CURE: with Notes on Davos Platz, Wiesen, St. Moritz, and the Maloja. By A. T. TUCKER WISE, M.D., L.R.C.P. 8vo. 1884. 108 pp. and map.

The author gives a resumé of his studies in the mountain health resorts of the Grisons, and includes winter observations of the Maloja Plateau, in the Upper Engadine. The intention in this volume is to exhibit the remarkable curative and health-giving properties of Alpine climate in their true light without exaggeration, or an omission of those minor details termed "drawbacks," so necessary to be portrayed in the consideration of any foreign or home health-resort.

THE MONTHLY WEATHER REPORT OF THE METEOROLOGICAL OFFICE FOR JANUARY 1884. Published by the Authority of the Meteorological Council. Official, No. 62. 4to. 1884.

This is a new publication of the Meteorological Office, and is arranged in the following order:—Section I. General summary for the month. II. Table of cyclonic storms. III. Remarks for January. It also contains a summary of the observations made at the telegraphic reporting stations in the British Islands, with wind and weather charts; and the storm tracks for the month.

TRANSACTIONS AND PROCEEDINGS OF THE NEW ZEALAND INSTITUTE, 1883. Vol. XVI. 4to. 1884.

Contains notes by Dr. Hector on the following subjects:—Remarks on Tidal Waves; on the earthquake disturbances in the Ocean; on oscillations of the barograph and celestial glows, and their connection with the recent tidal disturbances; and on sunset glows.

TRANSACTIONS OF THE HERTFORDSHIRE NATURAL HISTORY SOCIETY AND FIELD CLUB. Vol. II. Parts 7-9. December 1883—May 1884. 8vo.

Contains:—Report on the rainfall in Hertfordshire in 1882, by the Rev. C. W. Harvey (6 pp.).—Meteorological observations taken at Throcking, during the year 1882, by the Rev. C. W. Harvey (8 pp.).

ZEITSCHRIFT DER ÖSTERREICHISCHEN GESELLSCHAFT FÜR METEOROLOGIE. Redigirt von Dr. J. HANN. XIX Band. May to July 1884. 8vo.

Contains:—Messungen der Sonnenwärme, von O. Frolich (14 pp.). The author describes his apparatus and methods for the measurement of solar heat.—Beiträge zur Klimatologie der griechischen Halbinsel, von J. Partsch (6 pp.).—This paper, which is the first of a series on the climate of Greece, is devoted to a discussion of the climate of Corfu.—Einige Tafeln zur Berechnung des Wasserdampfgehaltes der Atmosphäre, von Dr. J. Hann (7 pp.). To the new edition of Jelinek's *Anleitung zu meteorologischen Beobachtungen* Dr. Hann has added some tables which are very useful in the case of barometrical reductions; and of these he gives explanations with examples and proofs, from which it appears that the variations in the hygrometrical condition of the atmosphere are not nearly as important in their influence on barometrical reductions as those of temperature.—Ueber die Isobarentypen in Italien und die Wetterprognosen, von Prof. P. Busin (4 pp.). The author has analysed the Italian Weather Reports for 2½ years, and grouped them under the classes,

Anticyclone, Neutral, and Cyclone. He finds that the types have a definite tendency to succeed each other according to ascertainable rules.—Das Klima von München, nach Dr. C. Lang (6 pp.).—Ueber die Bildung von Mittelwerthen bei der relativen Feuchtigkeit, von K. Weihrauch (9 pp.). The author proposes to employ instead of the ordinary arithmetic mean the fraction whose numerator and denominator are respectively the sum of the numerators and denominators of the several fractions representing the relative humidity at the given temperature.—Beiträg zur Frage der Bewegungsursachen der Depressionen, von M. Möller (4 pp.). The author discusses the effect of the motion of the air in cyclones upon their movements over the earth's surface. The resultant motion is shown to depend on the difference between the deviating effect of terrestrial rotation which causes the cyclone to move Westwards and the upper current depending on the temperature gradient between the equator and the pole, which makes it move Eastwards. Near the equator the former predominates and the cyclone moves Westward. Near the pole the latter factor is greatest and the cyclone moves Eastwards.—Marchi: Untersuchungen über die mathematische Theorie der Winde (8 pp.).—Die merkwürdigen Dämmerungserscheinungen des Herbstes und Winters 1883-84, von O. Jesse (7 pp.). The author replies to Dr. Hann's remarks on remarkable sunsets, which were directed to point out the difficulty of connecting them with volcanic outbursts, and urges his strong opinion that such a connection does exist.—Zur "Eismänner"-Frage (6 pp.). Dr. Köppen criticises Dr. Billwiller's statement that the cold days in May have no real existence. Dr. Hann in his turn replies to Dr Köppen, and Dr. Buys Ballot also joins in the discussion. The two last-named writers are not favourable to the cold period theory.—Sonnenschein im Jahre 1882, von Dr. J. M. Pernter (6 pp.). This is a discussion of all the sunshine results of which the hourly tabulations have been published, viz. St. Petersburg, Stonyhurst, Magdeburg, Vienna, Toronto, Woodstock, and Sydney (Canada), Pola, and Allahabad. The author proposes that the publication of results should be in hours and tenths, and that the daily and monthly sums for the hours, not means for the hours, should be given. He considers that he has discovered that continental stations have in summer less sunshine in the afternoon than in the forenoon, and in winter the reverse. The coast stations have most sunshine in the afternoon all the year round.—Einige neuere Resultate der meteorologischen Beobachtungen auf dem Obirgipfel, von Dr. J. M. Pernter (5 pp.).

ational Health Exhibition, 1884.

MEMORANDUM

ON

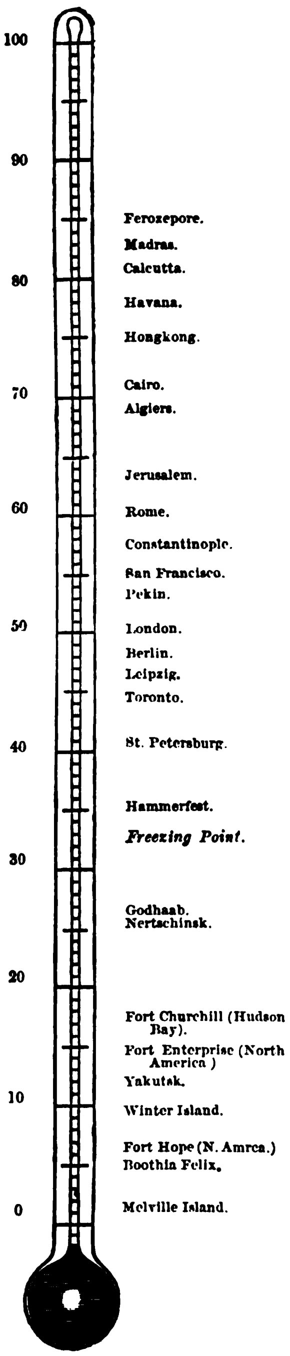
matological Observations

AND THEIR RELATION TO

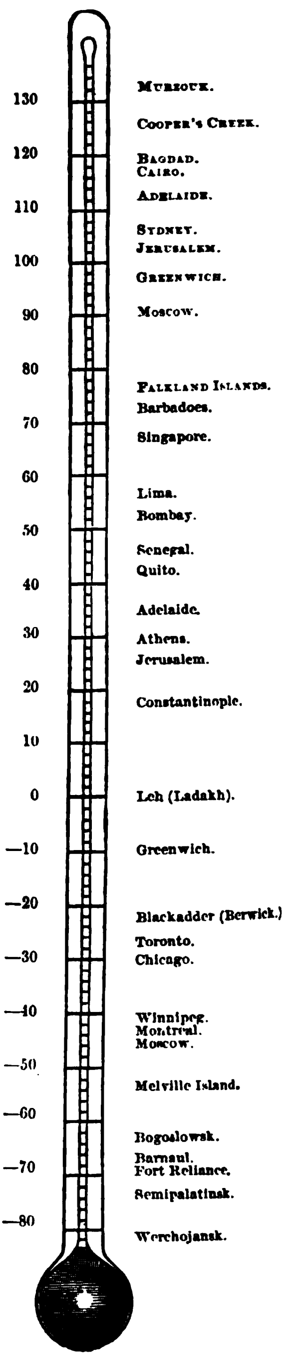
PUBLIC HEALTH.

PREPARED BY DIRECTION OF THE

AL METEOROLOGICAL SOCIETY.



Mean Annual Temperature of certain places in various parts of the World.



HIGHEST and LOWEST Temperatures observed at certain places in various parts of the World.

MEMORANDUM ON

CLIMATOLOGICAL OBSERVATIONS

AND THEIR

RELATION TO PUBLIC HEALTH.

THE intimate relations that exist between Meteorological changes and Health have attracted the attention of mankind for many ages, although the precise extent of their effects was in earlier times but little known. Much greater influence has been attributed to them in the production of plagues and other diseases spreading over a large extent of country than modern inquiry will support; and it is only in comparatively recent times, when accurate records of deaths have been kept, and correct meteorological observations made, that their true effects have been more nearly ascertained. Numerous books and papers have been written by statisticians on the relations between Health and Temperature, Humidity, prevailing Winds, and amount of Rainfall of a whole country or of particular localities: and it is in the hope of fostering a regular record of observations at numerous places, that the Royal Meteorological Society exhibits the equipment necessary for what is known as a "Climatological Station."

The necessary instruments are:—A Dry and a Wet bulb, a Maximum and a Minimum Thermometer, which are placed in one of the Society's Thermometer Screens, with their bulbs four feet above grass. This screen is a modification of the well-known Stevenson screen, and is believed to give fairly satisfactory results in even unfavourable positions, whilst the observed differences between it and other accepted screens are but slight. In addition, there is a 5 inch Rain-gauge, the top of which is placed one foot above the ground. These instruments are observed once daily, viz. at 9 a.m.

A Sunshine Recorder is also exhibited, which, although not included in the ordinary equipment of a Climatological Station, would be a

valuable addition thereto, because the amount of sunshine in any given locality is a very important consideration in choosing a residence for invalids, and even for persons enjoying good health. It will be noted that a Barometer does not form part of the equipment, as this is not a necessary instrument for ascertaining the climate of any particular place, though a desirable addition if the observer thinks proper to procure one and does not object to the cost.

By these instruments, observed daily for a number of years, the highest, lowest, and mean temperatures of a locality can be ascertained, the "relative humidity" (complete saturation of the air being represented by 100), the number of rainy days, and the total rainfall. For health purposes, as well as for the treatment of disease, the mean temperature of a place is not the only, or even chief, thing to be known, as the highest and lowest readings, as well as the range of temperature, must be taken into consideration in determining the most suitable climate for the residence of persons afflicted with, or having a tendency to, any special disease. The relative humidity is also of great importance, as dry air agrees with some persons, whilst damp (moist) air is more suitable for others. The effects of moisture on healthy and on diseased persons vary very much according to the temperature.

The Royal Meteorological Society receives returns of observations made with accurate and verified instruments at 82 stations, which are regularly inspected by the Assistant Secretary. The monthly results from these stations are published quarterly in the *Meteorological Record*. The Society is always ready to give all information to any one purposing to establish a station, whether he is a Fellow or not.

On the walls of the Meteorological Section of the Exhibition will be found a number of diagrams prepared by the Society, affording important meteorological information, and illustrating the influence of meteorological phenomena on the health and well-being of man.

The Meteorological Office exhibits diagrams showing the accumulated Temperature, Rainfall, and Hours of Bright Sunshine since the 1st of January, in several districts of the United Kingdom. These

diagrams will be corrected weekly, so as to show the character of the present season. The complete curves for the year 1881 are given on the diagram for the purposes of comparison.

Although the barometer is not a necessary instrument for ascertaining the climate of any particular place, it must not be supposed that it is an unimportant instrument; on the contrary, it is of the greatest value in tracing the track of storms, in forecasting weather, and in other ways; but it is not required at every small station, because variations in atmospheric pressure are nearly similar over a large area, and there are already a sufficient number of stations in this country at which barometers are to be found. There is also another reason, viz. that variations in the barometric readings at any one place do not apparently exert much direct influence upon health. A diminution in atmospheric pressure, such as is met with in balloons and upon very elevated plains and high mountains, necessitates a closely corresponding increase in the bulk of air inspired in a given time, and consequently exerts great influence upon healthy and diseased persons. Thus at the present time many persons suffering from consumption are sent to Davos Platz and other elevated Alpine places in winter, partly to inspire a dry and an attenuated atmosphere. Loss of sight, hearing, and the power of moving were experienced by Mr. Glaisher during a high balloon ascent (probably to the height of about 36,000 feet); but it is certain that these effects were caused simply, or chiefly, by diminished pressure.

The extremes of temperature which man can sustain, if he have proper and sufficient clothing and food, are very great. In the Arctic regions a temperature of $-70°$ Fahrenheit, *i.e.* more than one hundred degrees below freezing point, can be borne without danger to health, although the cold is sufficient to convert mercury into a solid mass and to freeze petroleum. On the other hand, man has lived in the interior of Australia at a temperature of 120° Fahrenheit, or nearly 90° above freezing point; so that he can live and be in good health within a range of nearly 200° Fahrenheit, which, as far as is known, no other animal can do. Fat foods, suitable clothing and dwellings, enable man to live in cold climates; whilst in warm

climates evaporation from the skin and lungs cools the body and keeps down the temperature of the blood below the point at which the continuation of life becomes impossible.

In a Paper read before the Royal Meteorological Society in 1862, and published in Vol. I. of its *Proceedings*, Dr. Tripe showed that 25·8 per cent. of all the deaths in London in 1859-61 from inflammatory diseases of the lungs occurred when the mean weekly temperature was below 35°; 17·8 per cent. when the mean weekly temperature was between 35° and 40°; 14·8 per cent. when between 40° and 45°; whilst the mortality only equalled 4·5 per cent. when the temperature was between 65° and 70°. The mortality from diarrhœa was shown to be only 9·2 per cent. of the total number of deaths from this cause, at mean weekly temperatures below 55° (which includes a large proportion of the whole year); whilst between 60° and 65°, it was 18·4 per cent.; between 65° and 70°, 27·3 per cent.; and between 70° and 75°, as much as 44·3 per cent. The increased temperature, however, is not the only cause, as a rise in the death-rate from diarrhœa in India does not equal that of England; so that great care as regards diet and clothing must be exercised in this country to prevent the injuriousness of extreme heat as well as of great cold. The excessive mortality in London from inflammatory diseases of the lungs was partly caused by fog, that is to say when the air was very moist and was charged to a greater or less extent with the products of the combustion of coal. A continued high temperature is not the only or direct cause of increased mortality from diarrhœa, as it probably acts injuriously on some articles of food, especially on drinking water, and on matter capable of undergoing putrefaction in the vicinity of inhabited houses.

It must not be supposed, as so much space has been devoted to a consideration of the connections between Meteorology, Health, and Disease, that the chief object of the Royal Meteorological Society is the fostering of "Climatological Stations." On the contrary, the Society has a number of higher class stations known to meteorologists as "Second Order" Stations, which have been organised to

assist in the investigation of scientific meteorology, and at which observations are made twice daily, viz. at 9 a.m. and 9 p.m.

We may appropriately conclude this Memorandum by asking, "What are the ultimate uses of Meteorology"? To this we may reply in the words of Mr. R. H. Scott, F.R.S., in his Lecture on "The Nature, Methods, and General Objects of Meteorology," delivered before the Royal Meteorological Society in 1878.

"The uses are twofold :—

"Firstly, there is the strictly scientific use, the enabling us to gain a more intimate knowledge of the conditions of our own atmosphere, and thereby of the earth as a member of the solar system.

"Secondly, however, its immediate practical use is the foretelling of weather. Shirk the admission how we may, it cannot be denied that the most abstruse discussion of meteorological data have hardly another object than the determination of the average conditions of the climate of each place, and of the amount of variability which may be anticipated in the march of each element. What is this but forecasting?

"In marine meteorology, again, we search laboriously for true mean values to indicate to the seaman where he may find "a fair wind and a favourable current," and what is this but implied prophecy?

"The fact is, there is not a profession, not a handicraft, not a process in animal or vegetable life, which it not influenced by meteorological changes, and there is not a human being to whom a knowledge of coming weather would not be of value.

"Had we, a quarter of a century ago, known the rigour of the Crimean climate, who would have dared to have sent out an army unprepared to meet the hardships of a Black Sea winter? Ask the physician at what price he would value the power of giving timely warning of the coming of a "cold snap" to his patients. Ask the builders of London what they have lost in the last ten years by sudden frosts or unexpected downpours of rain. Above all things,

go to the farmer, and ask what he would freely pay to know at seed-time what weather he might really expect in harvest.

"The roll is endless,—a knowledge of meteorology is of the very first importance in every stage of human life, civilised or uncivilised.

"Hence we learn the attractiveness of all the manifold attempts made to foretell the character of the weather and seasons, whether these be the venturesome storm warnings of our Transatlantic neighbours, or the sun-spot researches of Dr. Meldrum and Dr. Hunter.

"With reference to all such inquiries, my friend Captain Hoffmeyer has furnished me with an apt remark, 'When the proper time arrives, a Kepler will be surely forthcoming to discover the laws by which our science works; for us to endeavour to force the plant in its growth is hopeless.'"

G. J. SYMONS, F.R.S. }
JOHN W. TRIPE, M.D. } *Honorary Secretaries.*

30 Great George Street,
Westminster, S.W.

N.B.—Persons desirous of any information respecting the equipment of a Climatological Station, or wishing to become Fellows of the Royal Meteorological Society, are requested to communicate with the Assistant Secretary, Mr. W. Marriott, 30 Great George Street, Westminster, S.W.

Williams and Strahan, Printers, 7 Lawrence Lane, Cheapside, E.C.

QUARTERLY JOURNAL

OF THE

ROYAL METEOROLOGICAL SOCIETY.

VOL. X. OCTOBER 1884. No. 52.

METEOROLOGICAL OBSERVATIONS ON THE MALOJA PLATEAU, UPPER ENGADINE, SWITZERLAND, 6,000 FEET ABOVE THE SEA. By A. TUCKER WISE, M.D., F.R.Met.Soc.

[Read May 21st, 1884.]

THE increasing attention given to Alpine climate, as an adjunct in the treatment of some important diseases, renders a study of these cold climates, and the peculiar meteorological conditions experienced in the mountains, of much interest.

We are indebted to Dr. Hermann Weber for the first paper in England, just twenty years ago, on the value of a winter residence in the Alps for several forms of ill-health, especially scrofulous and pulmonary complaints. His statements and views met with but little consideration or attention at this time. Some "authorities" even treated him rather roughly for this "quasi-sensational and unreasonable practice."

Twenty-four years before this, however, Dr. Bodington, of Warwickshire, recommended "dry frosty air" for pulmonary consumption. He was also roughly handled by the reviewers, and on that account never pursued the subject. Within the last seven years Alpine winter residence has been brought more prominently before the public and the medical profession, chiefly by Drs. Theodore Williams, Symes Thompson, and Clifford Allbutt; but nearly all interest has been concentrated on one village of the Grisons,—Davos Platz—

5,000 feet above sea-level. Wiesen and St. Moritz also, both in the Grisons, have recently attracted winter visitors, and doubtless these places, which differ somewhat in meteorological conditions, will be appreciated for their slight variations from the climate of Davos, which latter has usually been held up as a suitable standard for comparison. The Maloja plateau is now developing into a health-resort; a large amount of capital has been expended in constructing an Hôtel-Kursaal with 400 apartments; in which all sanitary arrangements are carried out according to the teachings of hygiene. With the meteorology of this plateau, situated at the upper extremity of the Engadine, I shall now deal.

The Maloja or Maloggia (bad lodging-place) was so named on account of the danger to travellers from robbers and brigands in former days. At present, from personal experience, I can say that the *morale* of the Maloja in this respect has undergone a great change, for I have left thermometers and other instruments quite unprotected during the past winter in all parts of the plateau, some even lying on the snow; and I have never had any of my arrangements interfered with, although there have been hundreds of Italian and Swiss workmen passing my instruments every day.

The Maloja plateau is situated at the higher extremity of the Upper Engadine, and is well protected from Northerly, Easterly and Southerly winds. Facing the plateau is the lake of Sils, the largest in the chain of lakes between Maloja and St. Moritz. In contrast with the glassiness of its tranquil waters, and the clear blue of the sky, are the rugged crags of the higher Alps, clothed below with red firs and larches.

On the eastern wing of the lake and plateau lie the Bernina chain, comprising the loftiest mountains of the Grisons, studded with glaciers and snowfields to an extent of more than 350 square miles; the slopes of the Surlej, Corvatsch and Della Margna (their peaks rising to 10,000 and 11,000 feet) abut on the lake of Sils and the eastern side of the plateau, protecting the lower ground. Opposite and rounding towards the north-east, the rough broadside of Lunghino, Gravasalvas and La Grêve are in close proximity. To the south are the Muretto, Dei Rossi, Del Forno and Salecina; whilst a mile or so to the south-west are seen the prominent Piz Duan and the serrated crests on the eastern ridge of the Val Bregaglia.

By these mountains the plateau is screened from keen upper currents of air. The "Thalwind" or valley wind, which blows in every Swiss valley, seldom exceeding a force of 1 Beaufort scale, is by no means insupportable, and dies away in force and frequency when snow covers the adjacent regions. At this season and when the lake of Sils freezes, greater calm prevails, and the locality partakes of that Alpine stillness and sunshine which allows the most delicate individuals to be exposed to a low temperature without being conscious of any sensation of cold.

The instruments in use during the winter 1883-4 were by Casella, and had been all verified at the Kew Observatory. A Stevenson's screen of the old pattern was placed in the shade of a large châlet, and fitted with an arrangement admitting of its adjustment after a snow-fall to the ordinary

distance of four feet from the surface of snow. The nearest building was the châlet, sixty feet distant.[1]

In the Alpine climate a thermometer screen of any pattern should be placed in shade, otherwise the intense solar heat warms the wood-work and thereby raises the temperature of the interior, many degrees above that of the external air.

The treatment of the ice-covered bulb also requires great attention, or a wider difference will be noted between the two thermometers than ought actually to occur. This takes place during a rise in temperature, and if not met by moistening the muslin around the bulb half or three-quarters of an hour previous to observation, a false estimate of the amount of humidity will be made.

The dew-point and weight of vapour in the atmosphere were calculated from Glaisher's *Hygrometrical Tables* in conjunction with Apjohn's formula;—

$$F = f \frac{d}{88} \times \frac{h}{30}$$

when the temperature of the wet bulb was above 32°,

$$\text{and } F = f \frac{d}{96} \times \frac{h}{30} \text{ when below } 32^\circ \text{ Fahr.}$$

The force of the wind was noted according to the Beaufort scale, deduced from the readings, in miles, of an anemometer placed on high ground in an exposed part of the plateau, fourteen feet above the snow. Another anemometer was erected six feet above the snow in the garden, south-west of the Hôtel-Kursaal; this instrument registered from ¼ to ⅓ the number of miles of the former.

The past winter in the Engadine was not so calm as the previous four winters, owing to the exceptionally small quantity of snow which fell in November and December. The depth of snow even in mid-winter being unusually slight, many slopes and rocks were left bare, favouring absorption of solar heat by the earth, to be again radiated off into space during the night; and in this way giving rise to local movements of air.

At the end of January and during February the snow covering of the earth was from one to three feet deep, and the calmness, blue sky and sunshine at this time were typical of an Alpine winter. Although the mean temperature for February was 26°·5 at noon, no necessity to put on extra garments was felt. No great coats were needed, and a cold bath at a temperature of 41° could be taken with advantage and with less feeling of positive cold than in London during winter.

Mist or fog was observed five times during the winter :—in the month of November, not at all; December, twice; January, once; February, twice.

The hygrometric state of the atmosphere reached saturation fourteen

[1] The Paper was accompanied by Tables of daily observations for the four months. As these have been printed *in extenso* in Dr. Wise's recent work *The Alpine Winter Cure*, only a summary of the results are given with this Paper. *Ed.*

SUMMARY OF METEOROLOGICAL OBSERVATIONS TAKEN AT THE MALOJA DURING THE WINTER 1883-84.

Months. 1883-84.	At 9 a.m. Temperature. 9 a.m.	Mean Max.	Mean Min.	Amnt. Cloud.	At Noon. Temperature. Noon.	Mean Max.	Mean Min.	Amnt. Cloud.	Weight of Moisture in 10 cub. ft. of air.	Drying Powe[illegible] of air per 1[illegible] cub. ft.
	°	°	°		°	°	°		Grains.	Grains.
Nov.....	26·4	31·8	20·4	4·4	30·5	31·4	24·3	4·8	14·0	6·1
Dec.....	19·3	27·6	14·4	4·1	25·0	26·0	17·1	4·2	11·1	5·4
Jan.....	19·3	27·7	11·9	3·9	25·7	26·9	16·3	3·3	11·0	5·4
Feb.....	17·4	28·5	9·1	4·0	26·5	27·9	15·5	4·3	12·3	4·7
Winter	20·6	28·9	13·9	4·1	26·9	28·1	18·3	4·2	12·1	5·4

Months. 1883-84.	At 3 p.m. Temperature. 3 p.m.	Mean Max.	Mean Min.	Amount of Cloud.	Temperature. In Shade. Absolute Max.	Absolute Min.	Mean Solar Radtn.	1 foot below Surface.	Force of Wind.	Rain.
	°	°	°		°	°	°	°		Ins.
Nov.....	30·5	32·3	28·6	4·1	44·0	11·0	113·6	32·7	0·8	2·21
Dec.....	24·8	27·5	22·0	4·8	45·0	—2·0	89·0	31·1	1·0	1·03
Jan.....	27·3	29·8	23·2	2·8	41·0	—4·0	105·5	30·9	1·3	0·52
Feb.....	27·6	29·5	24·1	4·3	38·0	—7·5	108·7	30·8	0·7	0·84
Winter	27·5	29·8	24·5	4·0	45·0	—7·5	104·2	31·4	1·0	4·60

times only :—November, three ; December, five ; January, one ; and February, five.

The extreme temperatures noted in the day time were :—1° at 9 a.m. on February 19th ; 45° on December 26th ; and 148° for the black bulb thermometer *in vacuo* on February 18th.

The "drying power of the air" in the tables is the weight of vapour which ten cubic feet of air were still capable of absorbing at the time of observation. The mean "drying power" for the winter was 5·4 grains against a yearly average of 12 grains of vapour. Owing to this dry air being a bad conductor of heat, it is possible to quit a heated room and remain in the open air for several minutes without being able to recognise the wide difference in temperature, which, if the room has been over-heated, sometimes amounts to as much as 50°. To this absence of moisture in the air may be ascribed the immunity of the population from catarrhs, and the capability of animals to support the low temperature in the Alps.

One of the objects of the present Paper is to elucidate the opinions of Fellows on what, doubtless, is an important section of meteorology, viz. observations in reference to the Medical aspect of Climatology.

I am of opinion that from a medical point of view the usual rules laid down for meteorological observations are not altogether sufficient for testing what may be termed the physiological effects of climate. Many perhaps will agree with me in thinking that a special system of observation is needed for this kind of investigation.

To me it seems so, as the present methods and formulæ of meteorology give too little prominence to the details on which the features of climate in relation to health so much depend, and embrace considerations too general and vast to enable a clear conception to be formed of a health-resort from any meteorological report. The cause of this lies much in the manner of arrangement, and the comparative neglect of such important climatological elements as—absolute moisture ; the character of certain winds and their immediate effects on the sensations, or on vegetation ; solid particles in the air, as dust, pollen, &c. ; variations in temperature during the day time ; nature of soil and vegetation ; ozone and the electrical conditions of the atmosphere. To the first of these items, "absolute" humidity, the greatest importance should be attached, as it gives a much clearer impression of the quality of air than "relative" humidity. For example, if we calculate the quantity of watery vapour in a London atmosphere at 90 per cent. of relative humidity, with a temperature of 40°, we shall find it to contain 25 grains of water in 10 cubic feet; the air will feel cold, the skin will be clammy, the air passages chilled, and catarrhs will be prevalent. On the other hand, 90 per cent. of relative humidity in the Alps at a temperature of 25° will indicate but 14 grains, the skin will be dry, no danger of catarrh will be experienced, with an entire absence of disagreeable chilliness, attributable solely to the quantity and not to the percentage of vapour present.

DISCUSSION.

Dr. Marcet had listened to the paper with interest, but regretted that the observations did not extend over three or four years instead of a few months only. He wished to know why Dr. Wise had taken three observations daily of the maximum and minimum thermometers, and would have liked to have seen the relative humidity given in the tables. He also inquired whether the thermometer-screen was fully exposed to the sun, or sheltered by the house. He understood Dr. Wise ascribed to the dryness of the atmosphere the absence of the sensation of cold often noticed in the open air of that station, but he could not agree with this explanation of the phenomenon, as atmospheric dryness by increasing evaporation from the skin and lungs is known to act as a cooling agent. Dr. Marcet remarked that the evaporation of one grain of water carried away sufficient heat to raise the temperature of 960 grains of water by 1°. He had made observations on the amount of water evaporated from the lungs in the Island and on the Peak of Teneriffe ; at 10,700 feet on the peak, 3,489 grains, or about that amount of water would have been exhaled per twelve hours of the day time ; at 7,090 feet, 2,743 grains, at the seaside 2,032 grains ; which means that near the sea (sea-level) the amount of heat removed from the lungs in the day time by evaporation of pulmonary moisture would have been such as to raise 279 lbs. of water by 1°.

Dr. Williams remarked that not sufficient was known of these high altitude climates, and it was a pity that in the present paper there were only four months' observations to discuss. The Maloja was interesting meteorologically on account of its peculiar position. It was situated at the end of the Upper Engadine Plateau, and to the south there was an exceedingly rapid descent into a warm valley, where fig trees, chestnuts, &c. flourished. He was not aware of any other place in the Alps where so sudden a change from a cold to a warm climate took place. It might be expected that there must be strong winds at Maloja as the result of this great difference of climate, but Dr. Wise's observations showed that the force of the wind was not at all great. Mr. Waters' observations at St. Moritz also showed but little wind. With respect to the humidity of the air, it must be remembered that these observations were taken in the vicinity

of a lake, and in the summer some parts of the neighbouring land were swampy. The results of the observations at Maloja were similar to those obtained at Davos. He quite agreed with Dr. Wise as to the necessity of studying the physiological as well as the meteorological conditions in order to determine the effect on the body of the climate of a certain place, as although meteorology was very useful in this respect, doctors could not, by means of meteorological observations alone, decide as to the suitability of certain places to which to send their patients. He thought that some reference should have been made in the paper to Dr. Archibald Smith, who was the first to draw attention to the climate of high altitude stations, and adduced important testimony as to the effect of the climate of the Andes on phthisis.

Mr. ROSTRON remarked that it was very desirable to have a long period of observations in order to determine the climate of a place. He also inquired whether the 'Föhn' brought most of the snow in winter; and suggested that, as many Alpine men now visited Pontresina in winter, it would be easy to arrange for reliable observations being taken at that place.

Dr. TRIPE hoped that this was but the beginning of similar communications, as he considered that they were of great value. He was sorry that relative humidity had been omitted from the tables, and grains of moisture in 10 cubic feet of air inserted instead, as the amount of moisture given out from the skin depends on relative humidity rather than on the amount of moisture the air is at any particular time capable of holding in suspension. He then referred to the figures given in the tables, which seemed to show that the temperature reached its maximum before 9 a.m. and fell afterwards.

Mr. BALDWIN LATHAM remarked that he did not believe in relative humidity values, and considered that they gave very little idea of the actual amount of moisture contained in the air. With different temperatures there may be the same relative humidity, but very different quantities of vapour in the air. He thought the mode adopted by the author was preferable to recording relative humidity values.

The PRESIDENT (Mr. Scott) said that Dr. Billwiller had written a paper on the reversed "Thalwind" experienced in this particular district, which had appeared in the Austrian *Zeitschrift:* he would like to know how far Dr. Wise's observations agreed with the results given in that paper. It would be well if Dr. Wise would explain more clearly his method of thermometer exposure, and also state how far his observations agreed with those of the observer for the Swiss Government, if there was one in the district. With respect to the remark that there was an entire freedom from catarrh, &c. on the Maloja plateau, the same thing had been generally noticed in the Arctic Regions, and, in fact, General Sabine had said of Spitzbergen that nobody ought to die there, were it not for scurvy.

Dr. WISE, in reply, said he had omitted relative humidity from his tables because he considered it of very little importance, as without further calculation it gave no correct idea of the quantity of moisture contained in the air. He then gave some illustrations of the failure of relative humidity to convey any evidence as to the amount of evaporation from the lungs and body. The thermometer screen was in the shade of two large houses from sunrise till near sunset; it was also shaded by a large wooden screen when necessary, to prevent it becoming unduly heated by the sun, which struck it between the houses. The wind observations in the table referred to the day-hours only, and were calculated from the higher and more windy position of the two anemometers used. The general direction was the same as at Davos. Dr. Billwiller's observations of the Thalwind in the Maloja district were as far as he knew made in the spring, summer, or autumn, and further comparison and observation were needed to determine if summer and winter Thalwind were alike in direction and characteristics. His observations agreed fairly well with those taken by the Swiss observers, but with the Swiss method there is no very great uniformity in placing thermometer screens. His object in taking three observations of the maximum and minimum thermometers each day was to ascertain at what time of the day the greatest variation in temperature took place. The amount of watery vapour contained in the air on the Maloja plateau was very small, and the proximity of the lake made but little difference in winter as the whole area was covered with snow. He considered that dry cold air, causing evaporation, acted as one of the cooling

agents of the body; but that the sensation of cold produced in that way was greatly out-balanced by the diminution in conductivity of heat from the skin exhibited by dry air. It was moist cold air which abstracted most heat; and he held that the small quantity of watery vapour suspended in the atmosphere of cold regions was the principal climatic factor which rendered them habitable,—next came the tranquillity of air.

Some Results of an Examination of the Barometric Variations in Western India.[1] By Alfred Naylor Pearson, F.R.Met.Soc., F.C.S., A.I.C., Acting Meteorological Reporter for Western India. (Plate X.).

[Read May 21st, 1884.]

The importance of the discovery of anything calculable in the movements of the barometer has been widely recognised amongst meteorologists; mathematical relations between atmospheric pressure and others of the meteorological elements have been shown to exist; indeed a fair amount of evidence has been given that the foretelling of the barometric movements would carry with it the prediction, with more or less reliability, of the rainfall[2] and the general wind movements.

Attempts to discover in the barometric variations, other than the regular daily and yearly ones, anything calculable or systematic have hitherto been attended with little success. An irregular oscillation taking place in about five days, and one taking place in about eleven years, have been recognised; but beyond these, the movements have baffled almost all attempts to reduce them to system.

In the present paper an attempt will be made to show that, so far at least as Western India is concerned, there have been calculable elements in these variations. And although it will not follow that any particular system which may be found to exist over this area will necessarily exist in other parts of the world, or even over Western India during other years than those under examination, yet if it can be shown that over some one region and at some one period a quantitative relation has existed between the movements of previous and subsequent years, the presumption will naturally arise that some such relation may be discoverable over other regions and at other periods also.

Whilst examining the usual monthly curves of the abnormal variations of

[1] The greater part of the matter of this paper was worked out in the middle of August, 1883, whilst writing the Official Report on the Weather of the Bombay Presidency in 1882.

[2] In his *Brief Sketch of the Meteorology of the Bombay Presidency in* 1880, Mr. F. Chambers gives the following formula for calculating the rainfall during the monsoon months at Bombay from the position of the barometer:—

$$R = \cdot492 - 4\cdot37\ B + 13\cdot27\ B^2$$

R being the rainfall in inches, and B the corresponding abnormal of the barometer, also in inches.

arometer in Western India during the year 1882, an attempt was made in a better view of the broad features of the curves by computing the ages of the four quarters. On doing so it became apparent at once there was regularity in the curves, that in fact they exhibited a ble oscillation, there being a rise from the last quarter of 1881 to the t quarter of 1882, a fall from the first quarter of 1882 to the second, then ain a rise in the third quarter, and finally a fall in the fourth. But further an this, on computing the average of the four representative stations, arachi, Deesa, Bombay and Belgaum, and then examining the resulting urve, the curious fact became noticeable that the change between the third and fourth quarters of the year was very nearly the same as the change between the first and second quarters, being a fall of ·022 in. in the latter case and of ·018 in. in the former. This will be readily seen on a reference to the accompanying plate, Fig. A, which is the curve of the lower line of figures in Table VI., and may be taken as showing the average abnormal variations of the barometer over the greater part of Western India. In the section of the curve for 1882 it will be seen that the line *ab*, joining the points of the first and second quarters, is of almost the same length as, and is parallel to, *cd*, the line joining the third and fourth quarters; or, to state the same fact in another form, the angle *abc* is nearly equal to the alternate angle *bcd*. There is in fact a sort of symmetrical arrangement of the curve about the middle point of the year.

It then became interesting to determine whether this symmetry existed in any other years, and on projecting the curve as far back as 1876, it was found that it did exist. Thus in Fig. A it is seen to be present in 1881, as also in the years 1879, 1878, and 1876; and if the curve were extended back to 1872 it would be found to exist still, there being, however, an exception in 1874. The symmetry failed in 1871. It is a fact worthy of note that the exceptions to this symmetry during the years under consideration have taken place every three years, thus showing a tendency to a triennial period.

It seems justifiable to assume that this annual symmetry in the barometric abnormal variations is a special physical phenomenon; for although it is possible that such a disposition of the curves should have resulted on one occasion by chance, it is scarcely reasonable to suppose that it should follow year after year, in the manner above indicated, unless there were some specific cause. Consideration of a possible cause may be deferred to a later part of this paper; for the present, it may be stated simply that this symmetry is evidence of the presence of a half-yearly oscillation of the barometer, which, if it were not masked by other greater movements, might make itself evident in the abnormal curve during most years.

The existence of this symmetry makes it possible in some cases to foretell the position of the barometer in the fourth quarter, by calculation from the abnormals of the first three quarters. The calculation would be performed by the following simple equation:—

$$d = c - (a - b)$$

a, b, c, and d being respectively the abnormals of the first, second, third, and fourth quarters of the year, due observance of the algebraic signs of those abnormals being made. Calculated in this way, the values of the fourth quarters of the years 1872-82, as compared with the actual values, would be as follows:—

TABLE I.

POSITION OF THE BAROMETER ABOVE OR BELOW THE NORMAL IN THE FOURTH QUARTER OF THE YEAR.

Year.	1872.	1873.	1874.	1875.	1876.	1877.
	In.	In.	In.	In.	In.	In.
Actual	—·019	+·007	+·008	+·010	+·009	+·004
Calculated	—·017	·000	—·025	+·015	+·005	+·066
Difference	—·002	+·007	+·033	—·005	+·004	—·062

Year.	1878.	1879.	1880.	1881.	1882.
	In.	In.	In.	In.	In.
Actual	—·057	—·018	+·016	—·027	—·024
Calculated	—·052	—·013	+·027	—·021	—·028
Difference	—·005	—·005	—·011	—·006	+·004

From this table it will be seen that in only two out of the eleven years is the calculation more than ·011 in. wrong, and in only three out of the eleven is it wrong by more than ·007 in. If then we can tell in what years this symmetry of movement is not likely to be masked by other greater movements, a method will at once be afforded for calculating beforehand, with considerable precision, the average position of the barometer during the fourth quarter of those years.

There is reason to suppose that the failures of symmetry may in some cases be anticipated. It has been above remarked that so far as the years under consideration are concerned, the failure has occurred every third year, —in 1871, 1874, 1877, 1880,—and also in 1883. As will be seen by a reference to Fig. A, the failure is, in two of the cases there represented, connected with the turning-point of a maximum; this was the case also in 1871. In 1874, the failure was at a time when the turning-point of a minimum happened to be about the middle of a year; and it is to be noticed that in this case the failure is of an opposite character to that of the other years, when it was connected with the turning-point of a maximum, being a *plus* quantity for the minimum of 1874, and a *minus* quantity for the maxima of 1877 and 1880, as also of 1871.

The question naturally presents itself as to whether this discovery can be turned to account for calculating the barometric position during the other quarters of the year. There is reason for hoping that it may.

If we consider this symmetrical double oscillation to be a constant phenomenon, then any irregularities in it may be regarded as abnormities, being in fact abnormals of the abnormals. For the sake of convenience,

they may in the present paper be termed secondary abnormals, the term primary being reserved for the original ones.

Now the fact already pointed out, that in the case of the turning-point of a minimum the secondary abnormal was a *plus* quantity, whereas in the case of the turning-point of maxima it was a *minus*—seems to indicate that the failure of symmetry (that is to say the secondary abnormal) is due to the curve being (so to speak) bent out of shape by the presence of some more prominent oscillation of which the minimum and maxima here mentioned are features. If so, the secondary abnormal may be regarded as a measure of the amount of bending; which amount of bending, if the great oscillations of the curve have an ordinarily regular character, will indicate the general course the curve is about to take.

This indication would perhaps afford a simple enough method of foretelling the immediate course of the curve, were it not necessary to consider that modification of the secondary abnormals, due to "bending" of the curve in the first half of the year, as well as that due to "bending" in the second half. This consideration sometimes renders the matter complicated; though when applied in the cases of large failures of symmetry, the method seems to be fairly reliable in a general way.

Better results will be obtained, however, if the method be modified by taking advantage of another fact now to be brought forward; a fact not only of use in this respect, but of special interest in itself.

The secondary abnormal of any year is not the same in all parts of Western India, there is a marked difference between the north and the south. From the figures given in Table VI., it will be seen that the secondary abnormal (obtained from the expression $\{a{\cdot}b\}-\{c{\cdot}d\}$) for Karachi in the North is $-{\cdot}016$ in., whereas for Belgaum in the South it is $+{\cdot}018$ in. The barometric change, shown in the curve, Fig. A, between the last quarter of 1882 and the first quarter of 1883, is an upward one, that is to say, just the opposite of what would be expected if we used the method above described, and took Karachi as an index, but exactly what would be expected if we took Belgaum as an index. Again, in the year 1881 the secondary abnormal of Karachi is $-{\cdot}029$ in., whereas of Belgaum it is $+{\cdot}005$ in. Here again, where Karachi shows a *minus* quantity, and Belgaum a *plus* one, the barometric change shown in Fig. A between the last quarter of 1881 and the first quarter of 1882 is an upward one. In the year 1879, Karachi has a secondary abnormal of $+{\cdot}002$ in., whilst Belgaum has one of $-{\cdot}006$ in.; and now when the algebraic signs are the reverse of what they were in the two cases previously cited, the barometric change shown in Fig. A is also the reverse. From these three instances then it would be concluded that the barometric changes which occur in the South are a truer indication of what will take place over the whole area than are those in the North. It seems in fact that, so far as the fourth quarter of the year is concerned, the barometric changes which are about to take place over the whole of Western India appear in advance in the South.

If in the year 1882 we compare, not Karachi with Belgaum, but the average

of Karachi, Deesa, and Bombay, with Belgaum, then we get for the secondary abnormal for the three stations combined $-\cdot001$ in., as compared with $+\cdot018$ in. for Belgaum; and if the former be subtracted from the latter, a *plus* quantity ($+\cdot019$ in.) is obtained. If the same process be gone through for all the years since 1876, the following are the results:—

TABLE II.

SECONDARY ABNORMALS FOR THE FOURTH QUARTER.

Year.	1876.	1877.	1878.	1879.	1880.	1881.	1882.
	In.	In.	In.	In.	In.	In.	In.
Belgaum	+·012	—·041	+·009	—·006	+·011	+·005	+·018
Average of Bombay, Deesa and Karachi	+·002	—·068	—·009	—·002	—·019	—·010	—·001
Difference	+·010	+·027	+·018	—·004	+·030	+·015	+·019

Now it will be observed that in all those years where the differences in the above table are *plus*, the movement of the curve in Fig. A in the first quarter of the succeeding year is an upward one, as compared with the last quarter of the preceding year; and in the only instance where the difference is a *minus*, the curve in Fig. A shows a downward movement in the first quarter of the succeeding year. Carrying the process back as far as can be done, and comparing the differences between the secondary abnormals of the North and of the South with the movement of the first quarter of the succeeding year, the following results are obtained:—

TABLE III.

Year.	1869.	1870.	1871.	1872.	1873.	1874.	1875.
Difference between Secondary Abnormals of Belgaum and other Stations	In. +·020	In. +·066	In. +·010	In. +·007	In. +·020	In. —·003	In. —·006
Rise or Fall of First Quarter of succeeding year	—·026	+·003	+·012	+·016	+·007	—·022	—·024
Year.	1876.	1877.	1878.	1879.	1880.	1881.	1882.
Difference between Secondary Abnormals of Belgaum and other Stations	In. +·010	In. +·027	In. +·018	In. —·004	In. +·030	In. +·015	In. +·019
Rise or Fall of First Quarter of succeeding year	+·011	+·029	+·042	—·008	+·002	+·034	+·019

The results in the above table for the years 1869-75 are obtained only from the three stations, Deesa, Bombay, and Belgaum, instead of from the four stations; the hours of observation were not the same as during the subsequent years; and the secondary abnormals of Belgaum were subtracted from those of all the three stations, Deesa, Bombay, and Belgaum combined, instead of from only the remaining two. As regards quantity, these results

are therefore not strictly comparable with those of 1876-1882. It is to be noticed, however, that in all these years there is only one exception to the correspondence between the algebraic signs of the upper and lower lines. An explanation of the exception which occurred in 1869 can be given, though it is better to reserve it for a later part of this paper. It is, however, evident, that so far as the quality of the barometric movement in the coming season of each new year is concerned, we have here a very reliable guide, or at any rate should have had it for all the years 1871-1888. It is well not to be too hasty in generalising; for, as will be shown hereafter, there is reason to suppose that the period we are now dealing with was one of a special phase in the march by barometric variations.

Could this method have been used as a guide to the quantity of the barometric movement? Taking that period in which the results are quantitatively comparable, namely from 1876 to 1882, it will be seen that in 1876, 1877, 1879, and 1882, the figures in the upper and the lower line of Table III. are either identical or nearly so; it will also be seen that in 1878 and 1881, when the calculated figures are less than the actual ones, they are calculated from years of minimum movement; and that in the year 1880, when the calculated figure is too high, it is computed from a period of maximum movement. It is further very worthy of note in connection with this matter, that in the two years of minimum movement just referred to the points a', b', c', d', in Fig. A are similarly disposed. In 1882, it will be seen that the angle abc on the upper side of the line ab, and of course the alternate angle bcd on the lower side of cd, are each less than two right angles; this is the case also in 1879 and 1876. But in the years 1878 and 1881, these corresponding angles $a'b'c'$ and $b'c'd'$ are greater than two right angles; these two are therefore years of precisely the same character, the only difference being one of the amplitude of the movement. Now it is further worthy of note that the failure in the quantitative calculation from the secondary abnormals of these two years 1878 and 1881 (Table III.) is of the same kind in each case, that is to say it falls short of the actual, and it is also of the same quantity. The figures being reproduced, are as follows:—

	1878.	1881.
	In.	In.
Calculated from Difference between Secondary Abnormals of Belgaum and of other Stations	+·018	+·015
Actual Movement of First Quarter of succeeding year	+·042	+·034

If in the lower line of 1881 we substitute +·035 for the figure +·034, a small alteration which is allowable in consideration of the accidents of computation and observation, as well as on other grounds, it will then be seen that

$$\cdot 018 : \cdot 042 :: \cdot 015 : \cdot 035,$$

a result which makes it reasonable to look for quantitative relations in all such cases.

And this leads to another important point, and eventually to a consideration of those more prominent oscillations which have been spoken of as "bending" the curve (Fig. A) in such a manner as to produce the failures in the annual symmetry. Referring to Fig. A, it will be noticed that each of the years 1878 and 1881 which have similarly disposed abnormals (a', b', c', and d') are preceded by years of similar failures in the symmetry, the only difference between these failures of symmetry being one of quantity, not of kind. It will also be noticed that as the quantity of the failure of symmetry is large in 1877, so the amplitude of the downward movement in the succeeding year is large; and when the failure is small in 1880, then the amplitude of the succeeding year's downward movement also is small.

If a smooth line be drawn freely but carefully through the middle points ab, bc, cd, &c. in Fig. A, so that the first and third quarters shall always be above this line, and the second and fourth below it, then does not this line irresistibly impress one with the idea of waves on the surface of water, having their gradual rise, as for instance from a in 1876 to c'' in 1877, their broken crest, as for instance from c'' of 1877to a' of 1878, and their compensating fall, as from a' of 1878 to d' of the same year? Does not, indeed, the whole series appear to be in the main the resulting waves produced by a disturbing force which caused the great upheaval of 1877, the amplitude of the waves getting less and less until in the period between 1882 and 1883 the line has become nearly straight? It seems indeed to admit of very little doubt that the great trough of 1878 resulted as a reactionary oscillation from the great crest of 1877, and that the smaller trough of 1881 resulted as a reactionary oscillation from the smaller crest of 1880. If this be really the case, then the points d' should be as much below the normal line as the points c'' are above it. And what are the facts? The figures are—

c'' of 1877, $+\cdot051$ in.	d' of 1878, $-\cdot057$ in.
c'' of 1880, $+\cdot021$ in.	d' of 1881, $-\cdot027$ in.

These figures are most interesting, for they seem to suggest the possibility of obtaining a theoretical normal line. If it be supposed that owing to the contingencies of computation, the normal line has been computed too high, and should be computed $\cdot003$ in. lower, then the crest and the trough in each case are exactly compensating, being in fact $+\cdot054$ in. $-\cdot054$ in. and $+\cdot024$ in. $-\cdot024$ in. respectively.

It has been pointed out that the failure of symmetry in 1877 was of the same kind as that in 1880; and that as the large failure of 1877 was followed by a large downward movement in 1878, so the small failure of 1880 was followed by a small downward movement in 1881. It will be well, in place of a general statement such as the above, to substitute an exact mathematical comparison of the two cases; for if it can be shown that the amplitude of the downward movements in 1878 and 1881 are mathematically proportional to the failures of symmetry in 1877 and 1880, an important point will be gained. It has been stated that the annual symmetry in the barometric movements was evidence of the existence of a half-yearly oscillation; and

the best method of measuring a failure of symmetry in any year would perhaps be to state it in terms of the amplitude of the half-yearly oscillation of that year. But as the knowledge of that oscillation is yet too limited for such a purpose, the failure of symmetry may for the present be measured in terms of the change between the first and second quarters, that is to say by the expression $\frac{(a-b)-(c-d)}{(a-b)}$. Measured in this way the following results are obtained :—

$$\text{The failure of symmetry} \ldots \begin{cases} \text{in } 1877 = \frac{62}{15} \\ \text{in } 1880 = \frac{11}{6} \end{cases}$$

The amplitude of the downward movement in 1878, measured from c'' (1877) to d' (1878) is ·108 in.; and that of 1881, measured from c'' (1880) to d' (1881), is ·048 in. Now

$$\tfrac{62}{15} \ : \ \cdot108 \ :: \ \tfrac{11}{6} \ : \ \cdot048$$ [1]

and the exact mathematical proportion is established.

Now from this it is evident that if the barometer in one year shows a maximum like that of 1877 or 1880, it may fairly be expected that the general course of the movements in the succeeding year can be calculated with considerable precision.

Further, it may be pointed out that at the beginning of 1882 there is a small maximum, which seems to bear the same relation to the movement of 1880-81 that the small maximum of 1879 does to the great movement of 1877-78. It may therefore be reasonably supposed that the movements from 1880-82 are a reproduction on a smaller scale of the movements from 1877–79, and perhaps that all the larger movements since 1877 are in great part the outcome of the great upheaval of 1876-77.

In order that the main course of the investigation might be followed with more regularity, certain branches have been left unfinished in the earlier part of this paper. A further examination of some of these will now be proceeded with.

First, as to further proof of the existence of the half-yearly oscillation, of which it was stated there was evidence. The fact that by making calculations based upon the assumption of its existence so many accordant results have been obtained, is in itself evidence of the correctness of the assumption. But if the oscillation can be found in the normal curve of the barometer, there can then be little further doubt of its real existence. Fig. D is the normal annual curve of the barometer for the four stations, Karachi, Deesa, Bombay and Belgaum, combined. Now this curve, it will be seen, is not symmetrical about the central point of the year. A symmetrical curve may be obtained from this by adding the value of January to that of December and assigning the mean to each of the two months, the value of February to that of November, and assigning the mean to each, the value of March to October, and so on.

[1] $\tfrac{11}{6} \times \cdot108 = \cdot1980$
$\tfrac{62}{15} \times \cdot048 = \cdot1984$

If the values thus obtained be curved, the form Fig. E will be produced. If now Fig. E be subtracted from Fig. D, a residuum, of which Fig. F (drawn on a magnified scale, and for two years consecutively) is the curve, will be left. Here then, if this method be a right one, the existence is shown of the half-yearly oscillation, or more correctly speaking of the yearly double oscillation in the normal curve.

At first it might appear that the want of symmetry in Fig. D represents no special physical phenomenon, but is due to the fact that the periods of calendar months do not exactly fit with the general run of the curve, so that the middle point between June and July does not coincide with the proper middle point of the curve. But if this were the explanation, then the normal curve computed for each day of the year should not show this want of symmetry. On referring, however, to any such curve, as for instance Plate I. of the *Meteorology of the Bombay Presidency*, by Mr. C. Chambers, F.R.S., it will be seen that the want of symmetry still exists. Moreover, if such were the explanation, the residuum Fig. F, obtained by subtracting Fig. E from Fig. D. should be a single oscillation, being from maximum to maximum (that is, from April to April in Fig. F) similar in every respect to, but of a less amplitude than, Fig. E. It shows, however, a notable difference, being most decidedly a double oscillation.

A possible cause for its production suggests itself in the existence of some deferred effect of the ground temperature upon the atmosphere. Such a cause might perhaps give rise to the double oscillation. Fig. G is the temperature curve of the air in shade for the four stations, Karachi, Deesa, Bombay and Belgaum combined, reversed, so that the highest temperatures are figured lowest and *vice versâ*, and moved three months in respect to its position with Fig. F, so as to allow for any possible effect which may on the average be retarded in its action by three months. The curve bears a sufficient resemblance to Fig. F to make any suggested connection between the two worthy of consideration. But if the connection be of the nature of cause and effect, then any abnormal variation of the one should be accompanied by a corresponding abnormal variation of the other. But this, after an examination of the abnormal barometer and temperature curves for the selected years 1876, 1879 and 1882, has not been found to exist.

Fig. F may possibly be due to the annual variation in the amount of atmospheric vapour. Fig. H is the "Dryness" curve of the four stations combined, and bears a considerable resemblance to Fig. F. The dryness curve is computed from hygrometric observations taken only 4 ft. above the ground, and is therefore subject to the drawbacks which always attend observations thus limited. Perhaps if it were more representative of the whole height of the atmosphere, it might bear a closer resemblance to Fig. F. Then again Fig. F has been obtained by a method which has been only assumed to be a correct one. Perhaps Fig. F is merely an approximation to the form of the double oscillation, though in all probability it is a very near one. There is therefore room for slight divergences from an exact parallelism between Fig. F and Fig. H. The evidence would, however, be more satis-

factory if Fig. H were the "Vapour Tension" curve instead of the "Dryness." A comparison of the quarterly barometric abnormal curve of the years 1876, 1879, and 1882 with the quarterly abnormal curves of the "Dryness," "Humidity" and "Vapour Tension" during those years, affords very conflicting evidence, and does not strengthen the probability of the existence of any connection between Fig. F and Fig. H.

But whatever may be the real cause of the double oscillation, the form of that oscillation may throw some light upon two difficulties which before now will have suggested themselves. The first of these refers to the cause of the annual symmetry which has occurred during so many years in the barometric abnormals. For the purpose of the present demonstration it will be necessary to assume two premises which are imperfectly established. The first of these is the connection between Fig. F and Fig. H; and the second is that Fig. H would vary regularly with a uniform change in the degree of solar heat. The grounds for the first of these assumptions have already been pointed out. There are also grounds for the second. If the solar heat were to be uniformly raised for a period of twelve months, then it may be argued that there would be a rise in the dryness curve in January, February, March, and April. In May the same cause would on the whole produce a similar effect; as also in October, November and December. But in June, July, August and September, the Monsoon months, the effect should be the reverse, for owing to the greater evaporating power of the sun, there should be a greater amount of moisture; moreover, the cloud proportion and rainfall being greater, the cooling effect upon the earth's surface is greater, and so the air temperature being less, the dryness is also less. The general effect then should be an increase in the amplitude of the "Dryness" curve. The reverse would be the case if there were to be a uniform decrease of the solar heat. Making these two assumptions, it will then be seen that by a uniform increase in the solar heat throughout any year, there would be an increase in the amplitude of Fig. F, the increase being approximately the same for each half of the double oscillation; and hence the abnormal curve would have a symmetrical disposition. If there were to be a uniform decrease in the solar heat, there would be a decrease in the amplitude of Fig. F, and hence a symmetrical disposition of the abnormal curve the reverse of what would exist in the previous case. The abnormals in the first case would take the form of Fig. F, and in the second case the negative of it. Now whatever may or may not be known regarding changes in solar heat, it is at least admissible to suppose that such changes take place in many years with sufficient regularity to produce an approximation to the effects above described. It is, of course, possible that there should be a direct connection between the sun's heat and the yearly double oscillation of the barometer, independent of any connection of the latter with the variations in atmospheric vapour; and if such were the case, it may be supposed that the argument of the latter part of this paragraph would apply.

In the year 1876 the amplitude of the half-yearly oscillation was apparently nearly normal, for the abnormals of that year (see Fig. A) are dis-

posed almost in a straight line. In 1879, it appears to have been less than the normal; and in 1882 still less.

The second difficulty refers to the occurrence of the symmetry in the barometric abnormals only about the middle point of the year. Why should it not occur between the latter half of one year and the former half of the next? The answer to this question will be supplied if we consider the fact that the largest movement of Fig. F is in the middle of the year, and that at the end of the year the movement is very small. Fig. J is the quarterly form of Fig. F. Turning attention to Fig. J, let it be supposed that the amplitude of this curve is made to vary by some constantly decreasing or constantly increasing cause, as for instance (supposing the cause to be the sun's heat) by a gradual decrease or increase in the amount of heat given out by the sun. The variation thereby produced in the curve will take place in proportion to the rectangular ordinates of the curve. As the ordinates at a, d, a', and d' are very small, the variation at these points may be neglected. Let it be supposed that the heat increases or decreases by n amount each quarter, that the first quarter it is increased or decreased by n, the second quarter by $2n$, the third by $3n$, and so on; and let it be supposed that the variation produced in the amplitude of Fig. J by a unit of variation in the sun's heat is x. Then at b, the second quarter, the curve will vary $2nx$. If at c it varied also by $2nx$, perfect symmetry would be preserved; but one quarter having elapsed, the sun's heat has become varied by $3n$, so that the variation at c will be $3nx$, a quantity which will destroy the perfect symmetry, but which, however, we may suppose to be not sufficient to prevent there being a considerable approach thereto, quite as near an approach indeed as is presented by any year in Fig. A. But when the point b' has been reached, three quarters have elapsed, and the amplitude has therefore varied by $6nx$, a quantity quite sufficient we may suppose to destroy, or nearly destroy, any approach to symmetry between cd and $a'b'$. The words "or nearly destroy" have been used, for there might still be left a sufficient resemblance (in length and direction) between cd and $a'b'$ to make itself noticeable; just, indeed, as there is in Fig. A between cd of 1876 and $a''b''$ of 1877, or between $c'd'$ of 1878 and ab of 1879, or between $c''d''$ of 1880 and ab of 1881, or again, between $c'd'$ of 1881 and ab of 1882, or, lastly, between the latter half of 1882 and the former half of 1883. At c' of Fig. J the variation will be by $7nx$, an amount sufficiently near $6nx$ to allow of a near approach to symmetry.

To make the matter still clearer, let us deal with actual figures. Table V. gives the actual numerical values of figures F. and J. Let us take the quarterly values to be approximately as in the upper line of Table V.; where x indicates the amount of variation produced in the half-yearly oscillation by a unit of variation in solar heat. Let the amount of variation in solar heat be represented in the middle line of Table V., so that it shall increase up to the third quarter, and then gradually decrease. The results of multiplying the upper line of figures by the respective figures in the middle line are given in the third line. Now if the value of x in the lower line be

TABLE IV.

ANNUAL DOUBLE OSCILLATION OF THE BAROMETER IN ·00001 in.

Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
−300	−325	+1112	+2475	+2050	+625	−625	−2050	−2475	−1112	+325	+300
1st Quarter.			2nd Quarter.			3rd Quarter.			4th Quarter.		
+162			+1713			−1713			−162		

TABLE V.

SHOWING THE IMAGINED EFFECT UPON THE DOUBLE OSCILLATION OF VARIATION IN THE SUN'S HEAT.

	1st Quarter.	2nd Quarter.	3rd Quarter.	4th Quarter.	1st Quarter.	2nd Quarter.	3rd Quarter.	4th Quarter.
Variation in the Yearly Double Oscillation by a Unit of Variation in Solar Heat	$+2x$	$+17x$	$-17x$	$-2x$	$+2x$	$+17x$	$-17x$	$-2x$
Amount of Variation in Solar Heat	± 6	± 8	± 10	± 8	± 6	± 4	± 2	0
Resulting Variation in the Double Oscillation	$\pm 12x$	$\pm 136x$	$\mp 170x$	$\mp 16x$	$\pm 12x$	$\pm 68x$	$\mp 34x$	0

taken as ·0001 in., and the *plus* signs of the variation in solar heat be taken, the resulting variation for each quarter respectively will be as follows :—

$+$·001 in., $+$ ·014 in., $-$·017 in., $-$·002 in., $+$·001 in., $+$·007 in., $-$·003 in., ·000 in.

These values are represented by a curve in Fig. K. The changes from the first to the second quarter of each half-year are as follows :—

	First year.	Second year.
Change from first to second Quarter	$+$·013 in.	$+$·006 in.
,, third to fourth ,,	$+$·015 in.	$+$·003 in.

The resemblance of these figures to those brought forward in connection with Fig. A is very great.

The next matter which requires further development is the statement previously made that, so far as the fourth quarter of the year is concerned, there is an appearance as if the barometric changes about to take place over the whole of Western India make their presence evident first in the south. The question naturally presents itself as to whether this rule holds good in the

case of the other three quarters of the year. If we refer to Figs. B and C which are respectively the curves of Karachi in the north and of Belgaum in the south, it will be noticed that there is frequently a kind of balance between the barometric movements at these two stations in any year. Thus in 1882, *ab* of the upper curve is similar to *cd* of the lower curve; while *ab* of the lower curve is similar to *cd* of the upper one. Again in 1880, $a''b''$ of Karachi shows an upward movement from the first to the second quarter, and $c''d''$ of Belgaum shows an upward movement from the third to the fourth quarter; but $a''b''$ of Belgaum in that year shows a downward movement, as also does $c''d''$ of Karachi; and it is to be noticed that as the fall from c'' to d'' at Karachi is greater than the fall from a'' to b'' at Belgaum, so the rise from c'' to d'' at Belgaum is greater than the rise from a'' to b'' at Karachi. Again, in 1879 *cd* of Karachi resembles *ab* of Belgaum, while *cd* of Belgaum resembles *ab* of Karachi. So also in 1878, the $a'b'$ of the one resembles the $c'd'$ of the other. The year 1876 appears to afford an exception to this rule; but if reference be made to the curve drawn just above Fig. B in that year, and which shows the movements at Deesa, a station of nearly the same latitude as Karachi, the rule it will be seen still holds good. These facts are explicable on the supposition that the movements are in advance in the south during the first and fourth quarters of the year, and during the second and third quarters are in advance in the north; in fact, it appears that the movements commence in those regions where the sun's rays at the time are most nearly vertical. The effect of this in the case of the two maxima of 1877-78 and 1880-81 is very apparent. Thus in the latter maximum, at Karachi in the north (Fig. B) one part of the maximum arrives there early, viz. in the third quarter of 1880, but the other part arrives late, viz. in the second quarter of 1881; the maximum thus becomes divided into two distinct portions, and is consequently double-crested; but in the curve for Belgaum, that half of the maximum which in the north had appeared in the third quarter of 1880, is not properly manifested until the fourth, and then, coalescing with the early movement which arrives there in the first quarter of 1881, forms a single-crested maximum. Such it will be seen is the result in 1877-78 also. If this rule be a correct one, then a maximum falling with its centre in the middle of the year should be double-crested in the south, and single-crested in the north. A maximum occurred with its centre in the middle of 1879, but it is an unfavourable instance to which to refer, owing to its effects in the latter part being masked in the Belgaum curve by the early arrival of greater movements. In 1882, however, something of this effect can be seen.

If then this be a constant phenomenon, it may no doubt serve as a guide in obtaining a forecast of the coming position of the barometer during each quarter of the year. Its reliability for the first quarter during the last fourteen years we have already examined. The conditions of the case may be set forth as follows:—

The barometric position during the:

First quarter in the south is determined by the general barometric move-

ent of that quarter over the whole area, *minus* the movement which took lace in advance in the fourth quarter of the previous year, and has already lisappeared in the south, *plus* the early arrival of the movement which will be experienced over the whole area during the next quarter.

Second quarter in the north is determined by the general barometric movement of that quarter over the whole area, *plus* the late arrival of the movement which appeared in the south during the previous quarter, *plus* the early arrival of the movement which will be experienced over the whole area during the third quarter.

Third quarter in the north is determined by the general barometric movement of that quarter over the whole area, *minus* the movement which took place in advance in the second quarter and has already disappeared in the north, *plus* the early arrival of the movement which will be experienced over the whole area during the next quarter.

Fourth quarter in the south is determined by the general barometric movement of that quarter over the whole area, *plus* the late arrival of the movement which appeared in the north during the previous quarter, *plus* the early arrival of the movement which will be experienced over the whole area during the first quarter of the next year.

The difficulty lies in eliminating all determining elements except the advance movement. If the principle of the method be correct, the difficulty will doubtless be overcome in the course of time. At present it seems possible, by arbitrary processes and even by merely examining the curves with the eye, to obtain a general foresight of what is coming.

The next matter which presents itself for consideration is the tracing of the annual symmetry in the barometric abnormals during the years previous to 1872. Unfortunately the barometric records of Karachi for many of the years previous to 1876 have not been found strictly comparable with those of the other stations; and those of Deesa and Belgaum compare with each other and with Bombay, only as far back as 1869. Still, if the quarterly curve of Bombay alone be examined, light may be thrown on the matter. Fig. O is the quarterly abnormal curve of Bombay for the years 1847-1883. The dotted line running through the continuous one is simply drawn with a free hand to represent the average movements of the curve, and will serve to show more clearly its broad outlines.

In all the years 1847-71, that is in twenty-six years, there are but eight instances of the occurrence of the symmetry, namely in 1847, 1848, 1852, 1857, 1858, 1860, 1866 and 1869. This scarcity of its existence during so many years may be due to the unfavourable disposition of the larger oscillations of the curve, which being of irregular or short periods, or having their turning-points in the middle of the year, necessarily mask any symmetrical arrangement which might otherwise have been apparent. It will be noticed that there are three great oscillations of the curve—one with its maximum centering in the year 1855, another centering in 1866, and a third in 1877. This is the, already known, eleven-yearly movement. It will also be noticed that the first great oscillation—that centering in 1855—is low, indistinct, much

spread out, and many-crested; the next great oscillation—that centering in 1866—is higher, more distinct, and only three-crested; whilst that centering in 1877 is the highest, best defined, most compressed, and only single-crested.[1] It seems possible that the notable clearness of the annual symmetry during the years 1872-82 is due to the singleness of the great maximum, which having smooth and uniform features does not mask by smaller sub-oscillations the symmetrical movement.

With regard, again, to the annual symmetry, another possible explanation suggests itself—an explanation quite independent of the existence of the yearly double oscillation represented in Fig. F. Although there can be little doubt of the reality of the yearly double oscillation, and although the results obtained in Tables IV. and V. are remarkable, still it has not been claimed that those results afford a complete and satisfactory explanation of the phenomenon in question. Indeed there are some forcible objections which may be urged against such an explanation.

Fig. L is the curve for Bombay, similar in all respects to Figs. A, B, and C, but upon which has been superposed the monthly abnormal curve. Fig. M is obtained by taking the smooth freehand curve of Fig. L as a base line, and measuring from it the monthly positions. By this rough method the great oscillations are approximately eliminated. If Fig. M be examined, it will be seen that (disregarding the small oscillations in February 1879, in April and October of 1880, and in January of 1881) there are twenty-four oscillations; which occurring in eight years, are therefore on an average each four months in duration. It will further be seen that from 1876 to 1881 they are in some respects similarly disposed in each year. Thus each year contains a central maximum, with another maximum on each side. Further, during the five years 1877-81 the central maximum is greater than the two side maxima. Moreover it will be seen that although 1879 is of this type, yet it is distinctly different from all the other years; but 1878 on one side of that year, and 1880 on the other, resemble each other more nearly than they do any other years; and also 1877 resembles 1881; and, though more distantly, 1876 resembles 1882. This is an effect which would be produced by two series of oscillations, one of a periodicity nearly the same as the other—as, for instance, one of $3\frac{3}{4}$ months and the other of four months—and so placed with respect to each other that their nodes come together in some part of the year 1879. It is not necessary to suppose that these oscillations have always the same amplitude; they may commence gradually and die out gradually, others being raised in their place. There may also be mixed with them many other oscillations of small period. Whether they were persistent or dying out, it

[1] It might perhaps be more correct to speak of each maximum as three-crested: thus the maximum of 1855 was accompanied by side maxima in 1853, and in 1857-8; that of 1866, by maxima in 1864 and 1868; whilst that of 1877 was accompanied by those of 1873-4 and of 1880-1. In the last case the side maxima, having been at a distance of three and a half years from the central one, caused it to appear single-crested. If this view of the curve be adopted, then it may be observed that the side maximum which follows is higher than that which precedes the central one.

is evident that at any particular time the phase of the barometric movements (such as are represented in Fig. M) would depend upon the relative position of the two or more series of oscillations with respect to each other at that time. It is also evident that the phase would last for a number of years. Now it may be that during the years 1872-82 the phase was by chance such as to cause a symmetrical disposition in the quarterly averages; and it is possible that throughout the years 1849-71 the phase was not such as to cause a symmetrical disposition. If, however, such an explanation be adopted, then it will be necessary to account for the occurrence of the symmetry during the eight years 1847, 1848, 1852, 1857, 1858, 1860, 1866 and 1869.

It is worthy of note that, if the average of the yearly curves of Fig. M for the five years 1877-81 be taken, and this average be subtracted from Fig. M during the years 1876-81, and the resulting residual monthly values be put through a simple process of smoothing, then Fig. N is produced. In this curve there are decided indications of an 8½ or 9 monthly oscillation, beginning in the middle of 1876 and ending in 1880.

In conclusion, the following subjects seem worth further notice. *First*, the existence of the yearly double oscillation represented in Fig. F. *Second* the annual symmetry in the quarterly abnormals. This symmetry may be a constant phenomenon, which under favourable circumstances should always appear, and upon the existence of which it will be safe at all times to base calculations; or it may be the result of a chance conjunction of two or more series of waves or oscillations, and if so, calculations can be based upon its existence only during the time the barometric phase which gives rise to it shall last. But if there are always barometric phases lasting over a considerable number of years, the annual barometric variation during those years must necessarily be of a certain type, just as it is seen to be in Fig. M; and although the type may not be such as to produce the annual symmetry pointed out in Fig. A, still if for any particular phase its exact form can be ascertained, then by watching the variations from that form during individual years it may be possible, while the phase in question lasts, to gain some foresight into the coming changes. *Third*, the fact that barometric movements appear in advance in the south during the first and fourth quarters of the year, and in the north during the second and third quarters. And *fourth* the arithmetical proportions shown to exist between the great wave of 1877-78 and the smaller wave of 1880-81. It seems almost proved that the latter wave is a reproduction of the former, and since its individual features are proportionately diminished, that the oscillation is dying out. If this be the case, then it may throw some light upon the connection between barometric movements and variations in solar heat; for if the latter are the exciting cause of the former, then an action analogous to that of wind in causing waves on the ocean may be looked for. One long continued wind does not produce one great wave on the ocean, but several comparatively small ones, varying in length and amplitude according to the strength and uniformity of the wind.

TABLE VI.

QUARTERLY BAROMETRIC ABNORMALS FOR THE FOUR STATIONS, KARACHI, DEESA, BOMBAY AND BELGAUM FOR 1876-83 (IN ·001 in.)

Station.	1876.				1877.				1878.			
	1st Quarter.	2nd Quarter.	3rd Quarter.	4th Quarter.	1st Quarter.	2nd Quarter.	3rd Quarter.	4th Quarter.	1st Quarter.	2nd Quarter.	3rd Quarter.	4th Quarter.
Karachi	−27	−20	−3	+10	+17	+37	+47	− 3	+38	+20	−22	−51
Deesa	−14	− 6	−1	− 1	+16	+41	+49	− 3	+32	+21	−36	−58
Bombay	−10	− 7	+4	+15	+24	+34	+55	+ 6	+27	+19	−49	−63
Belgaum	− 4	− 8	+4	+12	+22	+29	+52	+18	+36	+ 7	−36	−56
Average of the Four Stations	−14	−10	+1	+ 9	+20	+35	+51	+ 4	+33	+17	−36	−57

Station.	1879.				1880.				1881.			
	1st Quarter.	2nd Quarter.	3rd Quarter.	4th Quarter.	1st Quarter.	2nd Quarter.	3rd Quarter.	4th Quarter.	1st Quarter.	2nd Quarter.	3rd Quarter.	4th Quarter.
Karachi	−13	−19	− 7	−11	−37	−32	+32	+18	+ 8	+12	−17	−42
Deesa	− 9	−17	− 5	−10	−34	−28	+16	+ 7	+14	+ 8	−24	−17
Bombay	−15	−25	+ 3	−19	−13	− 1	+28	+23	+33	+23	+ 6	−20
Belgaum	−22	−29	−12	−25	−20	−21	+ 8	+18	+19	− 5	−12	−31
Average of the Four Stations	−15	−22	− 5	−16	−26	−20	+21	+16	+18	+ 9	−12	−27

Station.	1882.				1883.			
	1st Quarter.	2nd Quarter.	3rd Quarter.	4th Quarter.	1st Quarter.	2nd Quarter.	3rd Quarter.	4th Quarter.
Karachi	+ 2	−12	+ 4	−22	+ 5	−31	− 2	+ 5
Deesa	+ 8	−18	− 8	−23	− 9	−30	−10	+20
Bombay	+16	− 4	+ 1	−20	+ 3	−13	+14	+13
Belgaum	+ 2	−27	−21	−32	−19	−35	−17	− 7
Average of the Four Stations	+ 7	−15	− 6	−24	− 5	−27	− 4	+ 8

NOTE.—The normal values from which the abnormals in this Table are obtained are the averages—

For Karachi of the observations of the years 1856-65, 1869-71, and 1876-80.
„ Deesa „ „ 1859, 1861-66, 1869-72, and 1876-80.
„ Bombay „ „ 1847-72.
„ Belgaum „ „ 1856-62, 1864-72, and 1876-80.

[Note added September 1884.]

In the above paper I have pointed out with regard to the quarterly abnormal curve of the barometer at Bombay (Fig. O of the diagram) that the three maxima which centre about the years 1855, 1866, and 1877, have a pro-

greater degree of distinctness and height: that the maximum of 1855 is the lowest and most spread out, and that of [illegible] is the highest and most concentrated, while that of [illegible] holds a medium position. Mr. Fred. Chambers, the acting Superintendent of the Colaba Observatory, Bombay, has recently shown me a paper which he has this year completed, and in which he has treated the diurnal variations of the horizontal force magnetograph in such a way as to get a curve resembling very closely the sunspot curve, but more regular. There are three periods embraced in this curve, which extends (to the best of my recollection) from 1842 to 1879. Amongst many other features which Mr. Chambers has noticed, is a progressive rise of the curve from the early years up to within a few years from the end, and also a less regularity in the first period than in the two succeeding ones. These facts are concurrent with those I have above pointed out.

THE EQUINOCTIAL GALES—DO THEY OCCUR IN THE BRITISH ISLES? By ROBERT H. SCOTT, M.A., F.R.S., President. (Plates XI. and XII.)

[Read June 18th, 1884.]

MOST scientific meteorologists are disposed to give up, almost in despair, the idea of eradicating from the popular mind the belief in the influence of the moon on the weather. There is, however, another belief, not quite so widely spread, but still very generally accepted, which attributes to the equinoxes a peculiarly stormy character. Over and over again have I heard the remark that it would be well for those proposing to take a voyage to wait until the equinoctial gales were over. It has struck me, therefore, that as we have had for several years past a regular system of storm warnings, it might be of interest to ascertain if the record of these warnings, and of the storms with which they were connected, exhibited any maximum of storm frequency about the equinoxes.

The period I have taken has been that of the fourteen years beginning with the spring of 1870, and I have commenced with the spring in order to include the past winter, that of 1883-4. With the year 1870, the systematic checking of storm warnings was commenced on the demand of the late Colonel Sykes. The results were published as *Parliamentary Papers* for the first seven years, and subsequently the returns have been regularly prepared in the Meteorological Office, though only the summaries of results have appeared in the Annual Reports. As these returns give not only the storms for which warnings were issued, but also those for which none were sent out, they afford a ready index to the storms which have been felt on the coasts.

Only such storms have been selected as have been really severe, such as have attained force 9 of the Beaufort Scale at more than two stations, with a velocity exceeding 50 miles an hour recorded by an anemograph for more

than a single hour. I have also not discriminated between the directions from which the strongest winds were felt.

The whole inquiry has been of a somewhat cursory nature. From its very character it does not admit of great accuracy; firstly, because the personal equation of the storm-reporters, such as lighthouse officials, is strongly marked—some of them reporting force 12 rather frequently!—and secondly, because the area with which we have to deal is too limited to be a fair gauge of the disturbances of the atmosphere at large. If a severe gale passes either over Spain or just outside the Shetland Islands, we shall have no record of it at our own stations.

In all questions of the periodicity of gales this difficulty crops up. Speaking of the general circulation of the atmosphere over the Atlantic, the fact that a gale does not affect these islands is no proof that it has not passed the meridian of Greenwich, either north or south of us. It would appear, and this we shall probably be able to demonstrate by our forthcoming Atlantic Weather Maps, that hardly a day passes when there is not a storm over some part of the Atlantic. The very time that we have had a dead calm, in an anticyclone over the British Isles, is the period at which the cyclonic storms strike the coast of Norway, north of the sixtieth parallel. In fact, the anticyclones are always accompanied by cyclonic depressions.

The mode of inquiry adopted has been to take fifteen day periods (that is, to take seven days on each side of the two Equinoxes), and to divide the year into equal intervals of this length. Of course we have had twenty-four such spaces, with a remainder of five days, which have been omitted at the beginning of July, that being the calmest part of the year.

There are represented on the diagram the dates of the several storms, and a curve is also given showing the march of frequency in the fifteen day periods.

These show that the storms are all but exclusively confined to the winter half-year, if we take that to include part of the autumn and spring.

A glance at the larger diagram (Table I.) will show how for a certain interval the stream of storm depressions sets over us, and then for a time takes another path, leaving us at rest. In some years we have as many as four or five storms in a fifteen-day period, and in others we have none, or only one. This happens even in the latter half of January, the stormiest period of all.

The diagrams show that there is no strongly-marked maximum at either equinox, but they do exhibit indications of periodicity which are very interesting.

Leaving the summer alone, as not worth notice, the frequency rises from nine and eight in the periods preceding the autumn equinox to ten at that epoch. The curve then rises rapidly, the value doubling itself and trebling itself in the two succeeding intervals. We then find a falling off at the time of the Martinmas summer in the first half of November, and a second maximum in the end of that month—the period indicated by Sir John Herschel long ago, in an article in *Good Words* for January, 1864, as that succeeding what he called "The Great November Wave," a phenomenon which

does not receive so much attention now as formerly. The first part of December is comparatively quiet, but after that, the frequency rises to its absolute maximum at the latter half of January, from which period the curve descends gradually, with one decided check in February, to the same value which it had in August, and which it attains at the end of April. The check in February reminds us of the well-known tradition of the "Halcyon" days at the end of winter. The frequency at the Spring Equinoctial period is nearly double what it is at the corresponding interval at the Autumn Equinox, being 19 as compared with 10. In one particular, however, the phenomena agree, the Equinoxes are periods of sudden change in storm frequency. In the autumn this rises from 10 to 20 as soon as the Equinox is passed; in the spring it falls from 27 to 19 as the Equinox arrives. Accordingly, persons who wait till the Equinox is passed in autumn, increase their chances of falling in with a storm, for the diagram shows no signs of a lull when once a heavy storm has occurred. In the spring it would apparently be wise to wait till April was well advanced, if you wished to get calm weather in the Bay of Biscay.

If we now look to see what evidence of recurrence of storms, for particular short periods, is discoverable in our data, we find that the day most frequently so distinguished is January 1st, on which a storm was recorded six times in the fourteen years. This is very remarkable, as December 31st only shows one, and January 2nd only two storms.

Five days, November 10th and 20th, January 18th and 19th, and February 26th, show five each, and no less than sixteen days show four.

The stormiest two-day interval is that of January 18th and 19th, which, as just explained, exhibit five storms each. The most disturbed three-day period is that of January 24th to 26th, where we find four storms on each day.

The date of the battle of Trafalgar, October 21st, is marked by two fours, on the 21st and 22nd, but the end of October is not so disturbed as the end of January.

The diagram also shows that almost every month in the year is occasionally nearly free from storms. October, November, December and January have only one apiece, but in different years. March is the only month which has at least two storms, thus justifying its epithet, "March many-weathers."

In conclusion, I may say that I am not the first who has attacked the notion that equinoctial gales were felt in Northern Europe. Dove, in the 4th edition of his *Gesetz der Stürme*, 1873, at p. 197, speaking of storms arising outside the Trade Wind zone, says:

"In Western Europe these storms are rare, and probably are never experienced in summer; we must now examine into the reason of this, and must take care to remember the changes in atmospherical conditions which occur in spring and autumn. Lucretius calls these epochs "the Wartime of the Year," and in fact an Italian may well speak of equinoctial storms. Such an expression, however, sounds strange from the mouth of a German,

TABLE I.—DATES OF STORMS (*beginning the year with April 13th*).

Month.	1870–1.	1871–2.	1872–3.	1873–4.	1874–5.	1875–6.	1876–7.	1877–8.	1878–9.	1879–80.	1880–1.	1881–2.	1882–3.	1883–4.
April	..	..	21	..	..	..	14	16	16, 21	14	18, 21	..	..	17, 30
May	12	..	4	..	..	..	..	..	19	..	..	16	..	..
June	..	..	..	..	..	..	..	1, 5	..	27	..	..	..	..
July	..	..	..	..	..	..	..	..	..	1, 20	..	..	..	..
August ..	..	24	..	28	..	..	2, 31	25	30	25, 27, 28	..	26	23	..
September	4, 9	27	24, 27	..	21	24, 27	30	13	15, 18	3, 22	14	..	2	1, 26
October ..	12, 15, 18, 23	1, 21, 27, 28	10, 23, 29	6, 10, 20, 22	3, 6, 9, 17, 21	6, 21	11, 16, 29	10, 13, 15, 20, 29, 31	7, 10, 22, 24, 28, 30	20	5, 7, 22, 27	14, 19, 21, 22, 31	1, 19, 24, 28	4, 15, 17, 25
November	10, 22	20	1, 6, 10, 23, 25	1, 10, 22, 27, 29	29	13, 19	11, 15, 23, 30	10, 11, 14, 15, 20, 22, 25, 28	8, 10, 12, 16	11, 20	9, 13, 16, 18, 25, 26, 28	16, 19, 20, 22, 24, 27, 30	1, 4, 5, 8, 14, 16, 20, 28	24, 27
December	22, 24	18, 20, 28	8, 16, 20, 22, 24, 27	16, 21, 29	4, 8, 11, 16	21, 24	3, 5, 10, 20, 26	6, 11, 25	31	4, 23, 27, 28, 30	10, 12, 18	6, 18, 20, 24	2, 5, 7	12, 14, 16
January	6, 10, 15, 16, 31	1, 3, 4, 5, 13, 17, 24, 25, 31	1, 4, 6, 8, 13, 18, 22, 26	1, 4, 8, 18, 20, 26	1, 3, 5, 15, 19, 24, 26	6, 18, 19, 24	4, 7, 18, 19, 23, 25, 28, 30	1, 21, 23, 55	7, 10, 17, 19	1	18	2, 6, 8	2, 10, 14, 19, 24, 25, 27, 28	23, 26, 27
February	5, 10, 12, 21, 23	1, 3, 12	2	10, 26, 28	24, 26	3, 15, 19, 23, 26	2, 19, 22, 26	17	..	6, 9, 13, 15, 16, 19, 26	7, 10, 13	13, 18, 28	1, 6, 9, 12, 14, 17	1, 10, 16
March ..	6, 7, 9, 12, 15	18, 28	10, 15	19, 27, 29	9, 11	3, 6, 9, 12, 15, 18	7, 12, 14, 25	6, 7, 24, 29	4, 5, 12, 28	1, 2	3, 18, 23	9, 22, 26	6, 8, 17, 22, 29	4, 20
April	..	3	..	1, 2, 12	..	10	..	7	..	..	2	..	..	..
Totals ..	26	25	29	28	22	24	32	32	25	27	25	27	36	21

for one cannot but think that he puts the equinox at Christmas, and forgets that September is the usual month for the occurrence of that phenomenon."

The Tables which are appended to the paper exhibit:—

I. The actual dates of the storms.
II. The diurnal frequency during the period.
III. The frequency in fifteen-day periods, and the same smoothed by the usual formula $B = \frac{a + 2b + c}{4}$

TABLE II.—Diurnal Frequency.

Date.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Date.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	6	3	1	1	..	1	1	..	1	2	3	..	17	2	2	1	1	..	..	..	..	..	2	..	..
2	2	2	1	2	..	..	..	1	1	..	..	1	18	5	1	3	1	..	..	..	..	1	1	1	3
3	2	2	2	1	..	..	..	..	1	1	..	1	19	5	3	1	..	1	..	..	..	..	2	2	..
4	4	..	2	..	1	..	..	..	1	1	1	2	20	1	..	1	..	..	..	1	..	..	3	5	4
5	1	1	1	..	..	1	..	..	..	1	1	2	21	1	1	..	3	..	..	..	..	1	4	..	2
6	4	2	4	..	..	..	..	..	..	3	1	2	22	1	1	2	..	..	..	..	..	1	4	4	2
7	2	1	3	1	..	..	..	..	..	2	..	1	23	3	2	1	..	..	..	..	1	..	2	2	1
8	3	..	1	..	..	..	..	..	..	..	2	2	24	4	1	1	..	..	..	..	1	2	2	2	4
9	..	2	4	..	..	..	..	..	1	1	1	..	25	4	..	..	..	..	..	..	2	..	1	3	1
10	3	4	1	1	..	..	..	..	..	4	5	2	26	4	5	..	..	..	..	..	1	1	..	1	1
11	..	..	1	..	..	..	..	..	..	1	3	2	27	2	..	1	..	..	1	..	1	3	2	3	2
12	..	3	4	1	1	..	..	..	..	1	1	2	28	2	2	2	..	..	..	..	2	..	3	3	2
13	2	3	..	..	..	..	..	..	1	1	2	..	29	..	..	3	..	..	..	..	..	..	3	2	1
14	1	1	1	2	..	..	..	..	1	1	2	1	30	1	..	..	1	..	..	..	1	1	1	2	1
15	2	2	3	..	..	..	..	..	1	3	2	..	31	2	..	..	..	..	..	..	1	..	2	..	1
16	1	2	..	2	1	..	..	..	..	1	4	4													

TABLE III.—Fifteen Day Periods.

Period.	No. of Storms.	Smoothed $\left(B=\frac{a+2b+c}{4}\right)$	Period.	No. of Storms.	Smoothed $\left(B=\frac{a+2b+c}{4}\right)$
April 13 to April 27	9	7·75	Oct. 15 to Oct. 29	33	27·25
April 28 „ May 12	3	4·25	Oct. 30 „ Nov. 13	23	28·25
May 13 „ May 27	2	2·25	Nov. 14 „ Nov. 28	34	28·0
May 28 „ June 11	2	1·5	Nov. 29 „ Dec. 13	21	25·75
June 12 „ June 26	0	0·5	Dec. 14 „ Dec. 28	27	26·25
July 2 „ July 16	0	0·25	Dec. 29 „ Jan. 12	30	31·25
July 17 „ July 31	1	0·75	Jan. 13 „ Jan. 27	38	32·0
Aug. 1 „ Aug. 15	1	3·0	Jan. 28 „ Feb. 11	22	27·5
Aug. 16 „ Aug. 30	9	6·75	Feb. 12 „ Feb. 26	27	25·75
Aug. 31 „ Sept. 14	8	8·75	Feb. 27 „ Mar. 13	27	25·0
Sept. 15 „ Sept. 29	10	12·0	Mar. 14 „ Mar. 28	19	18·75
Sept. 30 „ Oct. 14	20	20·75	Mar. 29 „ April 12	10	12·0

DISCUSSION.

Mr. Symons considered the results of this paper extremely interesting and useful, though he was rather astonished at them. With regard to the distribution of storms, it certainly did appear from the diagram that the time of the

equinoxes was not of a particularly stormy character. He had always understood, however, that the storms did not arrive here at the time of the equinoxes, but they originated in the tropics about that time, and reached the British Isles some weeks later; but even admitting this, it did not make the case for the equinoctial gale theory any better. He could not understand the absence of any marked maximum at or about the date of the Royal Charter Storm (October 25th), as some years since much evidence in favour of its periodicity had been brought forward.

Prof. ARCHIBALD said that the fact shown by Mr. Scott's diagram, that the storms were more frequent in the winter half-year, was a very interesting one, and was in agreement with the theory of cyclones as worked out by Ferrel, according to which the horizontal temperature gradient between their borders and centres was the chief factor in their production. As the temperature throughout the Northern Hemisphere was more uniform in summer than in winter, cyclones would not be so readily developed in the former season as in the latter.

Mr. C. HARDING remarked, with reference to the connection which Mr. Scott had drawn between the November wave of barometric pressure and the maximum number of gales experienced in that month, that he had long noticed the common occurrence of a very high barometer in February and a similar frequent occurrence of heavy gales in that month. He referred to the occurrence of gales at the Cape of Good Hope, and the manner in which the barometer observations showed that the months in which the range of barometer was large, gales were also of frequent occurrence, and the months of small range were much more free from gales. Prof. Archibald had remarked that wherever there was an area of low pressure there must be connected with it an area of high pressure. Doubtless this was correct in theory, but the high pressure area was often very hard to find in practice. He had lately been examining the synoptic charts of the late Captain Hoffmeyer, and from them it appeared that from January 4th to 17th, 1881, there was an area of low pressure which occupied a fairly fixed position in the middle of the North Atlantic, with a steady Easterly gale on its northern side, and in the track of trans-Atlantic vessels: during this period there were no travelling depressions on the eastern side of the Atlantic, until at length the disturbance which had existed for a fortnight passed off to the eastward, and in travelling over our Islands caused the memorable gale of January 18th to 19th.

Mr. LAUGHTON said that he had long maintained that the equinoctial gales were a myth, and it was satisfactory to him to see this opinion so strongly supported by the inexorable logic of figures. It was impossible to say what had given rise to the popular belief—perhaps some ancient storm, the effects of which had left a deep impression on the vulgar mind. It was, however, worth noticing that in modern times none of the great historic storms came at the equinoxes; they all agreed fairly well with the maximum periods now shown by Mr. Scott.

The PRESIDENT (Mr. Scott) in reply said that he had noticed in working up the paper that sometimes for two or three consecutive years the same period in each year would be marked by very stormy weather, and then would be calm for several years; accordingly the Royal Charter gale might have recurred frequently between 1860 and 1870, though this was not the fact subsequent to 1870. The period of fourteen years was not sufficient to give a smooth curve, and a much larger number of years would be needed to smooth the irregularities which at present existed.

ON THE PHYSICAL SIGNIFICANCE OF CONCAVE AND CONVEX BAROGRAPHIC OR THERMOGRAPHIC TRACES. By The Honourable RALPH ABERCROMBY, F.R.Met.Soc.

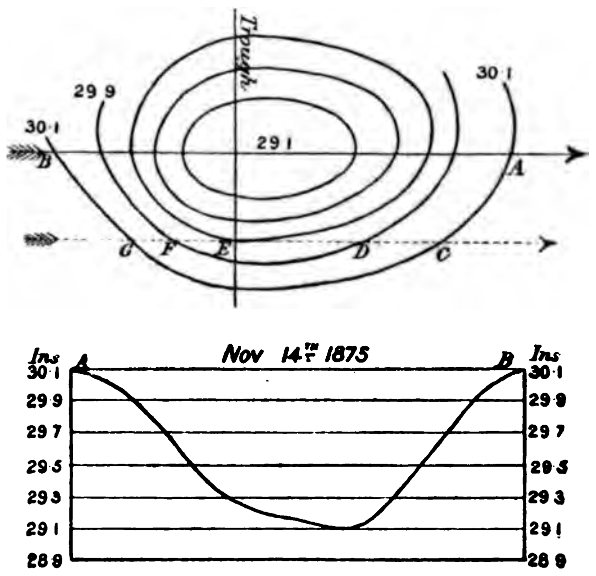
[Read June 18th, 1884.]

ANY one who is in the habit of watching a barograph, will have often noticed, that when the barometer is falling, the trace may be either concave or convex; that is to say, though always falling, the hollow of the curve is sometimes

turned upwards, when we call it concave, and at other times downwards, when we call the trace convex.

For instance, in a typical cyclone (fig. 1) the barographic trace is always convex at first, as at A; later on the curve becomes concave, and so continues till the mercury turns to rise. This is quite independent of the rate at which the barometer is falling. In rear of the cyclone the curve remains concave for a very short time, after which it becomes markedly convex. In some cases, the rising part of the trace is convex throughout.

Fig. 1.

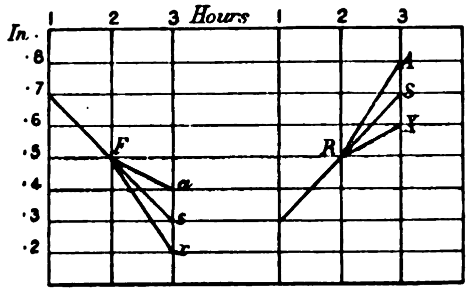


On a fine day, the sweep of a thermographic trace (see fig. 3) also presents some striking contrasts. Commencing at the lowest point, the curve is concave for a very short time. Then it becomes very convex about 10 or 11 a.m., and less so till the maximum is attained. In the afternoon the trace almost immediately becomes concave, and remains so for the remainder of the day. The convexity of the morning trace, as opposed to the concavity of the afternoon, is very curious.

Suppose, as in fig. 2 F, that the barometer fell 0·2 in. between 1 and 2 o'clock, and another 0·2 in. between 2 and 3 o'clock—the resulting barographic trace would be a straight descending line like *s*. If in the second hour the mercury fell 0·3 in. instead of only 0·2 in., the resulting trace would be a convex line like x; while if it only fell 0·1 in. in the second hour, the trace would be concave as marked a.

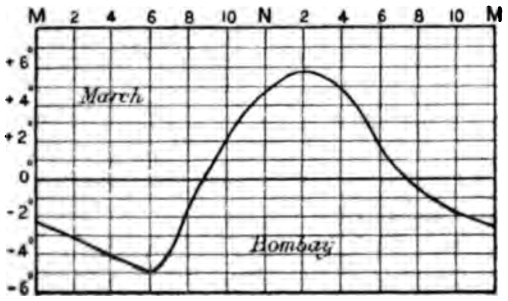
If barometric rate be defined as the number of hundredths of an inch which the mercury moves either up or down per hour, it may be expressed as follows;—With a falling barometer the trace is convex for an increasing rate,

FIG. 2.



concave for a decreasing one. A glance at fig. 2 R will show that for a ıg barometer the converse is the case, for when the rise is greater in the ınd than in the first hour, the trace is concave, as in A; but when less ı it is convex, as at X. Therefore with a rising barometer the trace is rex for a decreasing rate, and concave for an increasing one. This is reverse of what happens with a falling barometer.

FIG. 3.



he simplest case of barometric change in this country occurs when a well-ıed cyclone drifts past any station; the flexures of a barogram can then asily followed. In an ordinary British cyclone, of the westerly type, there ring of rather steep gradients some way from the centre in front of the ression; a long oval area of low pressure some distance in front of the ıre; while in rear, the steepest gradients are found quite close to the centre. ı is well shown in fig. 1, which gives the isobars over Great Britain on ember 14th, 1875, at 8 a.m. The arrow denotes the direction of ion of the cyclone, and the unsymmetrical arrangement of the steepest lients with reference to the centre is very obvious.

'o get the barographic section of a cyclone, or to find out what curve the ɔagation of the depression would have on a recording instrument, a line ıt be drawn across any portion of the plan, as shown on a synoptic chart, ıllel to the path of the cyclone; and then by measuring the distance in

time between any two consecutive isobars the flexures of the trace will be obtained.

For the sake of simplicity, we shall suppose, in the first instance, that we are stationed in the path of the cyclone, and that the centre will pass exactly over us. By this we make the line of section of the cyclone coincide with the line of gradients, which is not the case in any other portion of the depression. The lower part of fig. 1 shows such a section of the cyclone, sketched in the upper portion along the line AB. The position of A and B is reversed in the section, so as to read from left to right, like an ordinary barogram. (The curve, as recorded at Stonyhurst, almost in the central line, differs only slightly from this.)

The normal barographic trace in a cyclone is therefore simply the reflection of the typical shape of isobars in that kind of depression; and to a single observer, the direction of curvature, that is the convexity or concavity of a barogram, enables him to tell whether more or less steep gradients are approaching, and whether a gale is going to get better or worse.

Though the future of forecasting certainly depends on the progress of research on the nature of synoptic charts, any hints towards making forecasts from observations on a single barometer, and on the appearance of the sky, will always be valuable. The author hopes that this new test, by which a solitary observer can sometimes infer the change in the steepness of the gradients which are approaching him, may be considered a small contribution to an increase of knowledge in this direction.

There is, however, one limitation, which considerably detracts from the value of this deduction. If the line of section of the cyclone which passes over the observer is not square to the isobars, the relative distance between any two consecutive isobars is no longer a measure of the gradients. For instance, in fig. 1 (p. 242):—If that cyclone had passed over an observer any where on the dotted line CG, the trace from C to E would have been concave, because CD is a shorter line than DE. But all the time he is getting into a region of steeper gradients, as measured square to the isobars, and therefore the criterion of increasing gradients fails.

But if a concave trace need not be an absolute test of decreasing gradients, a convex trace can never fail to indicate steeper gradients with a falling barometer. This may be readily seen by considering the nature of concentric lines. Conversely, with a rising barometer we see in fig. 1 that from E to G the barogram will be concave, though the gradients are decreasing; but under no possible conditions could a convex trace fail to indicate a decreasing gradient.

The author would, then, lay down the following rules, which will be the more valuable now that efficient barographs are so cheap.

Assuming that the force of a gale is proportional to the gradients, a convex barogram is always a bad sign with a falling barometer, and a good sign with a rising one. A concave trace is sometimes a good sign with a falling barometer, and not always a bad indication with a rising one.

These rules of course involve the supposition that the motion of the baro-

meter is due to the translation of isobars over the observer, but in practice much more complicated changes sometimes occur. For instance, in a very common class of gale, belonging to what the author has described as the Southerly type of weather, a cyclone after arriving near the British coasts remains stationary, but the central barometric pressure decreases by perhaps 0·5 in.

The fall of the barometer which then occurs at any station is no longer of the same kind as that which we have just examined, and the flexure of the trace is determined by other considerations. The direction of curvature would then depend on any variation of the rate of deepening, and not on the motion of the cyclone.

For instance, suppose a stationary cyclone, which began to deepen from increasing intensity. If the rate of deepening was constant, the trace would be a straight descending line. If the rate increased, the curve would be convex; if it decreased, concave. But as we know that the deepening of a cyclone means intensity, we may look on a decrease of that rate as a favourable sign, and therefore the indications of the relation of curvature to weather would remain good. The complications which arise from a deepening or shallowing moving cyclone need not be discussed here, but it is important to notice the two distinct causes of barometric change—the passage of a moving cyclone, and the deepening of a stationary one.

The general conclusion then is, that the curvature of a barogram depends on an increasing or decreasing rate of change, either upwards or downwards; and that a knowledge of it sometimes enables a solitary observer to deduce valuable indications as to whether a gale is about to increase or to decrease in force.

Flexure of Thermograms.—The general shape of a thermogram or the diurnal curve of temperature all over the world is tolerably uniform. After falling from midnight till some time between 4 and 6 a.m. with a concave trace, the temperature then rises quickly, more or less, according to latitude, with a strongly marked convex trace till 2 or 3 p.m. The temperature then falls rapidly, and the curve till midnight is concave. The curve cuts the line of mean temperature about 8 or 9 a.m. and 8 or 9 p.m. A fair specimen of such a trace is given in fig. 3, which represents the diurnal curve of temperature range at Bombay in March, as deduced by Mr. Chambers.

As the general character of diurnal heat variation is practically the same all over the world, whatever the absolute temperature may be, it follows that we may conceive an ideal set of diurnal isotherms being propagated round the world. Then the diurnal heat curve would be the product of the passage of diurnal isotherms, just as a barogram is the product of the passage of non-diurnal isobars; but we might readily conceive a set of diurnal isobars being propagated round the world, which would be superimposed on the isobars due to the great areas of high and low pressure. The sun is the principal source of all heat, and, if nothing disturbed his rays, there would be a regular diminution of temperature from the Equator to the Pole, which

might be considered as a thermal slope. Every day, as the earth turned under the sun, a well-defined wave of variation would be superimposed on this slope. The lines which mark out the shape of this deflected slope are what we have called *diurnal isotherms*.

We must now consider how to deduce some knowledge of an ideal representation of the diurnal variation of isotherms on a map of the world from observations on the daily range at any one place. At first sight this would seem impossible, but it is easily done by the following method. For simplicity we must assume a uniform surface to the earth, so that there may be no unequal heating of land and water; and also, that if there were no diurnal range, there would be uniform isothermal slopes from the Equator to the Poles. The isotherms would then, of course, be parallel to the lines of latitude, and any number of degrees of latitude might be required to measure the distance between any two isotherms, according to the steepness of the thermal slope. As there would be no unequal heating, the diurnal range would be every where identical in the same latitude.

From this conception we easily arrive at the idea that a fall of 1° in temperature at any place is equivalent to moving an isothermal line so many miles south, that is, to an alteration in its latitude. For instance, suppose at midnight the thermometer registered 60°, that is to say, that we were under the isotherm of 60°; then if by 6 a.m. the temperature had fallen to 59°, that would show that the isotherm of 60° was south of us.

If now we mark on one side of the map a scale in which 1° of temperature is represented by the number of degrees of latitude which naturally corresponds to one thermal degree, we have only to plot the diurnal curve on the map according to this scale, and then we have a picture of the theoretical displacement of the isotherms at any hour. For instance—suppose that in latitude 20° N the diurnal temperature curve at any station was given by the following simple values :—

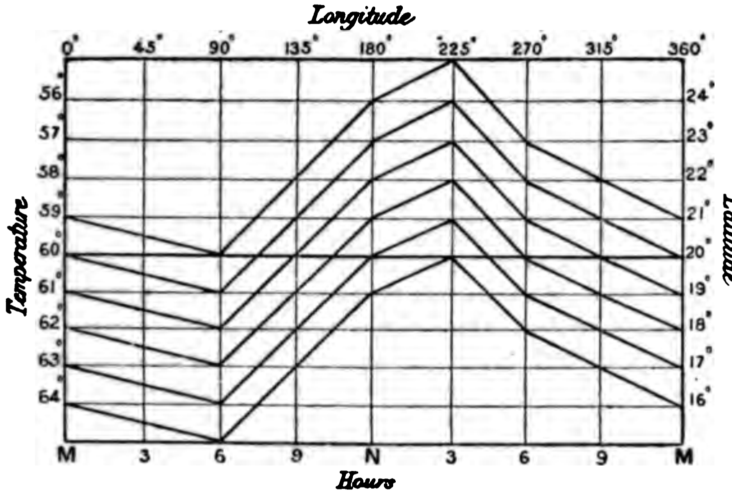
Midnight, 60°; 6 a.m., 59°; Noon, 68°; 3 p.m., 64°; 6 p.m., 62°.

We can deduce from that the position of the six isotherms, 59°—64°, at any hour. Let fig. 4 (p. 247) represent a portion of the map of the world on Mercator's projection, on the assumption that for short distances the spaces between the lines of latitude may be considered constant. Meridians of longitude are marked on the top, and the equivalent intervals of time are indicated below. Then, for simplicity, suppose that 1° latitude is equivalent to 1° of thermal slope; then 1° on the scale of latitude on the right of the figure will be equal to 1° of temperature on the left.

First, to trace the isotherm for the midnight temperature:—Mark the number, 60°, on the first midnight hour line, at the level of latitude 20°; then, as by 6 a.m. the range curve points to 59°, if we want to follow the isotherm of 60°, we must go 1° of latitude further south to find it. This gives the position of the isotherm of 60° in longitude 6 hours, or 90° longitude. By noon the range curve has risen to 63°, so that we must go 3° further north of latitude 20°, in longitude 180°, to follow our isotherm of 60°.

In like manner the whole of the range curve at one station in latitude 20°

FIG. 4.



can be employed to plot the latitude and longitude of the 60° isotherm all round the world, by turning time into longitude and range into latitude.

Now with the same limitation that the isothermal slope is uniform, we may suppose that 1° further south there is a similar diurnal range curve, only 1° higher, which can be plotted in the same way as the last. This is shown in the diagram, by starting the isotherm of 61° on the 19° parallel of latitude.

Similarly the whole six isotherms can be drawn; this has been done in the figure, and then we have a picture of the ideal distribution of temperature over the globe in latitude 20° at noon on the meridian of 180°. We see, moreover, that the shape of the diurnal isotherm on a Mercator chart is the same as that of the diurnal range curve, if we turn time into longitude and temperature into latitude, on a suitable scale.

If in our undisturbed world we could walk round the earth in 24 hours, in any latitude, the line marked 60° on the chart represents what our journey would be if we wanted to keep under the uniform temperature of 60° during the whole day.

If we tried to perform this operation all over the world, the amount of variation and the hours of change would vary considerably. This would in no way affect the argument. It is manifest that as the diurnal range diminishes from the Equator towards the Pole, the isotherms would conform gradually from one extreme to the other, so that within the range of any latitude the above reasoning would hold good.

We can now partially explain the origin of the morning convexity and afternoon concavity of an ordinary thermogram. We may conceive that this diurnal shape of the isotherms is propagated over any station, parallel to the lines of latitude, by the earth's rotation. A section of the isotherms along

any latitude, therefore, gives the diurnal range curve. The difference in actual level of temperature at different places in the same latitude is in practice due to the unequal heating of land and water, or other causes. But, whatever the actual temperature may be, the character of the diurnal variation is the same, for the diurnal isotherms are propagated over any others which may be due to more general causes.

Now if we look at the manner in which the line of latitude 20° cuts the isothermals in fig. 4 (p. 247), it will be seen that the curve must be concave about 6 a.m., so as to give a minimum at all; then as the line of 20° latitude cuts four isotherms between 6 a.m. and noon, and only one from noon till 3 p.m., and as the number of isotherms cut in a given time is proportional to the rate of increase of temperature, the curve must be convex in the morning. In like manner, as the temperature falls 2° between 3 and 6 p.m., and only the same amount from 6 p.m. till midnight, the trace must be concave in the afternoon. This, then, gives the explanation of a typical thermogram.

From this point of view the origin of a thermogram is analogous to that of a barogram. With a rising temperature the passage into steeper thermal gradients is marked by a concave trace, while that into slighter gradients gives a convex curve. Conversely with a falling temperature the passage from steep to slight gradients gives a concave, and that from slight to steep, a convex trace. Or an increasing rate gives a concave curve with a rising, and a convex one with a falling temperature; a decreasing rate gives a convex curve with a rising, and a concave one with a falling temperature.

But the diurnal trace and the chart of the diurnal distribution of temperature only tell the same story in a different form, for one is merely the reflection of the other. We must, therefore, endeavour to explain why the diurnal isotherms take the shape which we have just found. The real physical basis of the varying curvature of the diurnal trace seems to be that after the sun has gained a certain power in the morning its heating influence decreases rapidly; while in the afternoon the fall of heating power is very rapid at first, but slower later on. Why this should be so we cannot altogether explain. Theoretically the sun's radiating power increases as the exponential of his zenith distance, but in practice the actual curve of temperature is very different.

Some general reflections on the subject may be made in conclusion. If the diurnal curve of temperature in any place could be expressed by a simple harmonic series of the form $A+B\ sin.(\theta+C)$, the curve would be equally convex on each side of the maximum, and equally concave on each side of the minimum, while the point of contrary flexure would be exactly on the line of mean temperature, that is, on the line of level variation. But as the curve is convex in the morning, the harmonic expression for the actual curve involves a large term, of which 2θ is the argument, and then the line of mean temperature no longer coincides with the point of contrary flexure, where the curve changes from concave to convex.

The idea has been suggested that the term involving 2θ has a harmonic origin, in the nature of all periodicities to form subsidiary variations of shorter

period, and that the semi-diurnal variations of the barometer, and perhaps of the wind also, are dependent on this peculiarity of the heat curve.

The author, however, thinks that the origin of the flexure is the unequal rate at which the air takes up heat from the sun; and that the harmonic term which contains 2θ is simply the necessary geometrical expression of an unsymmetrical trace. He can find no support for the idea that each term of a harmonic series has a different physical source.

In connection with the flexure of a simple harmonic curve at the line of level of variation, the author may perhaps be permitted to notice some unsuccessful researches on the question of the level of a cyclone.

If we suppose that some portion of a cyclone is above the general level of the atmosphere, and some below, it would be of the utmost value in the theory of cyclones to determine what the level of any cyclone was.

For instance—the pressure at the lowest point of a cyclone may be as high as 30·0 ins., and yet that must be below the level of the adjoining regions; or the highest part of a winter cyclone may be only 29·5 ins., and yet that must be above the general level of the surrounding atmosphere.

The author has spent much time in the attempt to discover the level of variation of a cyclone by means of the flexure of barographic traces, but he has come to the conclusion that the direction of curvature of a barogram depends on the causes which have been fully detailed in this paper, and that a method of finding out the level of a cyclone has yet to be invented.

The results of this paper may be summarised as follows:—The author shows that a falling barogram is convex when the rate of fall is increasing, and concave when it is decreasing; and conversely, that a rising barogram is convex when the rate is decreasing, and concave when it is increasing.

As the rate of barometric change is proportional to the steepness of the gradients which are passing, and the wind also depends on the gradients, he is able to lay down the following rules for estimating the coming force of a gale from the inspection of a barogram. A convex barogram is always a bad sign with a falling barometer, and a good sign with a rising one. A concave trace is sometimes a good sign with a falling barometer, but not always a bad indication with a rising barometer.

[The convexity or concavity of a thermogram is in the same way shown to depend on the rate of thermal change.]

The author gives a method by which the distribution of diurnal isothermals over the globe can be deduced from the diurnal thermograms in different latitudes; and shows that the shape of diurnal isotherms on a Mercator chart, for a limited number of degrees of latitude, is similar to the shape of the curve of diurnal temperature range, if time be turned into longitude, and temperature into latitude, on a suitable scale.

MARITIME LOSSES AND CASUALTIES FOR 1883, CONSIDERED IN CONNECTION WITH THE WEATHER. By CHARLES HARDING, F.R.Met.Soc. (Abstract.)

[Read June 18th, 1884.]

THE shipping interests of England are so large, that any matter which can be said to have a bearing on the subject is of sufficient importance to discuss.

Shipping casualties and losses are regarded to a very great extent as the concomitants of bad weather, and rightly so too, for if we study the wrecks on the coasts of the United Kingdom, for example, it will be found that the number is proportionately higher or lower in accordance with the stormy nature of the weather.

Although Insurance Companies, and indeed all who are interested in shipping, readily admit that the weather is the main cause of the loss of ships, yet meteorologists have at present scarcely attempted to utilise the records of the number of casualties as an index of the weather experienced.

With the object of connecting wrecks with the weather, I applied to the Secretary of Lloyd's for a list of the casualties and total losses which occurred on the coasts of the United Kingdom during the year 1883, and I would here acknowledge the ready kindness with which the information was furnished.

The lists of Maritime Losses and Casualties supplied by Lloyd's are for the several weeks ending Wednesday, a division of time for which meteorological statistics are not usually prepared, indeed I have been able to obtain only the Kew Diagrams published by the *Times* with which to compare the lists. Fortunately these are for weeks ending on Wednesday; but I admit that the comparison of wrecks in the British Islands with observations at Kew is very poor, and I should prefer using similar data for all the other self-recording observatories in the United Kingdom; the labour of this, however, in the absence of published results in a convenient form, places such an undertaking altogether beyond my power as a private worker.

With the view of connecting the casualties with the storm-centres or depressions which influence the weather of our Islands, I have also used the valuable Monthly Weather Reports published by the *Times*, in which maps are given showing the track or passage of each depression.

The following details will probably assist in judgment being formed as to the relation existing between Wrecks and Weather in 1883; for brevity only the most prominent features of the weather are mentioned.

January.—Frequent gales passing over the Northern Coasts. The storms of 25th and 26th were very severe, bringing up the list of casualties in one week to a total exceeding that of the previous four weeks. Many storms were felt in America, of which a great number crossed the Atlantic, and the path of the centres followed a very similar route from Newfoundland to the British Isles.

February.—A stormy month—most of the storm centres, however, passing to the westward of our Islands, except the gale of the 2nd, which crossed England centrally. Losses in the first week in excess of those for the total remainder of the month.

LIST OF MARITIME CASUALTIES AND LOSSES, WHICH HAVE OCCURRED ROUND THE COASTS, OF THE UNITED KINGDOM, REPORTED AT LLOYD'S, ON LOSS BOOK, DURING 1883.

1883. Week ending.		Casualties.			Total Losses.	KEW.			
							Wind.		
		Sailing.	Steam.	Total.		Range of Barometer.	Maximum Velocity in miles per hour.	Direction.	General Direction in Days.
						in. in.			
an.	3	3	2	5	2	29·5—30·1	31	SW	6 W, 1 Vble.
,,	10	22	5	27	15	29·5—30·5	35	SSE	4 E, 2 S, 1 W
,,	17	12	4	16	8	29·3—30·2	20	S & E	4 E, 2 S, 1 W
,,	24	14	2	16	8	29·7—30·6	28	S	3 S, 3 E, 1 W
,,	31	58	8	66	31	29·0—30·1	45	SW	6 W, 1 S
eb.	7	52	5	57	37	28·9—30·3	35	S	3 S, 3 E, 1 Vble.
,,	14	45	5	50	19	29·3—30·0	40	S	5 S, 1 W, 1 E
,,	21	17	3	20	10	29·9—30·5	22	S	3 S, 2 W, 2 N
,,	28	4	3	7	4	30·4—30·8	22	W	6 W, 1 N
Iar.	7	31	5	36	21	29·7—30·7	38	N	4 N, 3 E
,,	14	20	8	28	13	29·5—30·0	26	E	3 E, 3 N, 1 W
,,	21	14	3	17	12	29·4—29·8	31	E	2 E, 2 N, 2 W, 1 S
,,	28	7	5	12	2	29·2—30·2	45	NE	4 W, 1 N, 1 NE. 1 E
pr.	4	20	3	23	9	29·4—30·3	30	S	2 N, 2 E, 2 S, 1 W
,,	11	6	2	8	3	30·2—30·6	26	E	4 E, 1 SE, 1 W, 1 N
,,	18	7	2	9	4	29·4—30·3	27	S	4 W, 2 S, 1 E
,,	25	7	2	9	3	29·5—30·2	37	NE	4 N, 2 W, 1 NE
Iay	2	3	—	3	3	29·4—29·9	28	E	4 E, 1 N, 2 W
,,	9	12	2	14	7	29·5—29·9	27	E	3 E, 3 N, 1 W
,,	16	10	1	11	7	29·5—30·3	28	S	4 S, 2 W, 1 E
,,	23	3	3	6	1	30·0—30·4	17	NW	2 N, 2 E, 2 SW, 1 W
,,	30	4	2	6	2	29·6—30·2	20	SW	2 N, 2 W, 2 SW, 1 SE
une	6	4	1	5	1	29·7—30·2	25	NE	4 NE, 2 SW, 1 E
,,	13	6	4	10	4	29·7—30·3	18	NE	2 N, 2 NE, 2 SE, 1 W
,,	20	4	1	5	2	29·7—30·3	15	NW	4 NW, 2 W, 1 SE
,,	27	4	—	4	2	29·7—30·0	22	SW	6 SW, 1 E
uly	4	3	5	8	3	29·7—30·1	25	W	5 SW, 1 W, 1 E
,,	11	2	1	3	2	29·6—29·9	28	SW	4 SW, 2 W, 1 S
,,	18	8	—	8	3	29·5—30·2	25	S	3 SW, 3 W, 1 N
,,	25	10	1	11	6	29·5—30·0	19	W	3 W, 1 NW, 1 N, 1 S, 1 SW
ug.	1	5	4	9	7	29·5—30·2	20	N	2 SW, 2 W, 2 NW, 1 N
,,	8	6	3	9	6	29·6—30·2	32	W	6 W, 1 NW
,,	15	9	—	9	4	29·5—30·2	35	W	5 W, 1 SW, 1 NW
,,	22	5	2	7	2	29·8—30·3	18	NW	2 W, 2 NW, 1 N, 1 SE, 1 SW
,,	29	4	3	7	2	29·8—30·3	19	NW	2 W, 2 NW, 2 E, 1 N
ept.	5	36	3	36	21	28·8—30·0	38	S	5 W, 1 N, 1 S
,,	12	5	6	11	3	29·8—30·2	21	W	2 W, 1 NW, 1 N, 1 NE, 1 S, 1 SW
,,	19	10	6	16	8	29·9—30·2	11	E	2 E, 2 W, 1 NW, 1 NE, 1 S
,,	26	19	6	25	9	29·5—30·1	25	SW	2 W, 2 SW, 2 S, 1 E
ct.	3	14	3	17	10	29·2—30·0	30	N	3 N, 2 W, 1 NW, 1 NE
,,	10	7	2	9	5	29·4—30·5	34	N	3 N, 2 NW, 2 W
,,	17	12	4	16	4	29·3—30·1	28	S	2 W, 2 S, 1 SW, 1 NE, 1 E
,,	24	13	2	15	7	29·6—30·2	25	NW	4 W, 2 NW, 1 SW
,,	31	15	5	20	7	29·7—30·4	24	W	2 NW, 1 NE, 1 E, 1 SE. 1 S, 1 W
ov.	7	20	3	23	8	28·9—30·2	31	SW	2 NW, 2 SW, 1 SE. 1 E, 1 W
,,	14	12	2	14	8	29·6—30·2	17	W	3 W, 2 N, 1 N, 1 NE
,,	21	11	5	16	5	29·5—30·1	26	SW	4 W, 3 SW
,,	28	6	5	11	4	29·0—30·4	31	W	6 W, 1 N
ec.	5	21	5	26	8	29·5—30·4	28	N	3 N, 2 W, 1 NW, 1 SW
,,	12	29	6	35	15	29·3—30·5	43	NW	3 W, 2 N W, 1 N, 1 NE
,,	19	76	12	88	42	29·4—30·4	32	N	3 N, 3 W, 1 NW
,,	*24	11	3	14	5	29·9—30·5	22	W	4 W, 2 NW, 1 S
,,	†31	9	9	18	10	30·1—30·5	22	E	4 E, 3 NE
		767	187	954	444	28·8—30·8	45	SW & NE	

* 5 days. † Ending on Monday.

March.—A fairly quiet month. A northerly gale of exceptional violence on the 6th, resulting in the loss of 382 lives on our East Coast. 21 vessels reported as totally lost in the week ending March 7th. This gale was chiefly due to a high barometer in the west, coupled with a depression moving southeastwards from Scandinavia, causing a steep gradient for Northerly winds.

April was particularly free from gales. Number of losses very low in consequence; the 23 casualties and 9 total losses reported in the week ending the 4th being doubtless due to a gale on the 29th and 30th of March.

May.—A very quiet month, the force of the wind scarcely reaching that of a fresh gale any where in the British Islands.

June.—Extremely quiet weather. The North Atlantic was almost entirely free from storms during the month.

July.—The weather, though not so calm, still maintained its summer character. The winds were generally Westerly.

August.—A few more losses occurred this month, but the storm-centres passed, without exception, either over Scotland or altogether to the North of our Islands. A rather heavy gale blew on the 8th and 9th. On the 28th and 29th a storm passing over Scotland can be traced to well within the Tropics. This gale caused a vast amount of destruction off the Coast of Newfoundland on the 26th, and was referred to in my paper to the Society on the Storm of September 1st to 3rd.

September.—A great increase in the number of casualties and losses due to a severe gale on the 1st to the 3rd, the force of which was chiefly felt on our Western and Southern Coasts. 21 vessels reported as totally lost in the week ending the 5th. The storm is the one which has been traced back to as early as August 24th, when it had the force of a strong gale in lat. 21° N. (see *Quarterly Journal*, Vol. X. p. 7).

October passed over very quietly; there were only two gales of any real importance—those of the 16th to 18th and 24th to 25th—but both of these had their centres well to the northward of our Islands.

November passed without a single gale of any violence. In all the four weeks ending 28th, only 25 vessels were totally lost. Atlantic very stormy.

December was generally quiet, but a severe gale, with its centre passing over Scotland, visited us on the night of the 11th to 12th, occasioning a heavier loss to shipping than any gale during the year. 88 casualties and 42 total losses were reported in the week ending 19th, and showed this to be one of the most severe gales of the last few years. North Atlantic very stormy, but the depressions mostly followed a northerly track, giving us little wind but much rain.

As was stated in the commencement of this Paper, the author's main object has been to suggest the subject for discussion; and he wishes it to be borne in mind that the occurrence of a single gale of a certain type on the coasts of the British Islands may cause greater loss of life and property than dozens of other gales, he therefore considers that especial attention should be given to these disturbances. As an instance of what is meant might be cited the gale of January 18th, 1881, which, for the week ending January

22nd, raised the number of wrecks on the coasts of the United Kingdom to 108 vessels. The principal mischief occasioned by this gale was due to the existence of an area of high barometric pressure to the east of our Islands, which caused a check to the progress of the storm's advance, and resulted in prolonging its duration of and intensifying its force.

Another instance may be taken from the gale of October 13th to 14th of the same year, a discussion of which is printed in the Society's *Journal*, Vol. III. p. 17, 1882. In consequence of this gale 108 vessels were posted on the Wreck and Casualty Book at Lloyd's in one day, and the number of lives lost and missing in one week reached 678, a number almost unprecedented. The destructive character of this storm amongst the shipping may be greatly attributed to the undeveloped nature of the front half of the storm, which led navigators and fishermen to suppose that no wind of great severity would be experienced; but the rear of the disturbance proved to be of unusual violence; to this, as well as its sudden outburst, we must attribute the loss of about 200 lives on the coast of Berwickshire alone.

I am of opinion that a proper systematic discussion of wrecks in relation to the storms which caused them, in such a manner as would admit of the loss to life and property occasioned by a severe storm being compared with its own weather, would do much to lessen disasters at sea, and would also introduce a certain standard of reference to show the severity of a storm on our coasts, much in the same way as an anemometer shows the force of the wind at one definite spot.

Climate of the Delta of Egypt in 1798-1802 during the French and British Campaigns. By W. G. Black, F.R.C.S.E., F.R.Met.Soc.

[Read June 18th, 1884.]

Ample materials are to be found in the works on the campaigns in Egypt in 1798, 1799, 1800, 1801, and 1802, for drawing up a scheme of the Climate of that period, notwithstanding the paucity and kind of instruments then used by scientists.

Meteorological records are to be seen in the accounts of the proceedings of the Turkish Army in Syria and Egypt from 1799 to 1802, by Dr. Wittmann of the Royal Artillery, 1803, in Dr. Desgenettes' work on the *Medical History of the Army of the East*, 1802; and in Dr. Assalini's treatise on the *Plague in Egypt*, 1804. The two latter authors were on the medical staff of the French Army under General Bonaparte, the former being Surgeon-in-chief, and having charge of the Grand Hospital at Cairo, and the latter being Surgeon of the Consular Guards of the French Republic. No continuous sets of observations, however, taken by officers attached to the British Forces, have appeared in the accounts of the campaigns, which seems somewhat singular, as Dr. Wittmann, R.A., had been able to get instruments for his use when attached to the escort of the Grand Vizier, commanding the Turkish Army. The observations

that are here tabulated do not refer to one place only during the year, but to Cairo and other localities where the observer happened to be stationed in the Delta of Egypt during the movements of the Forces.

The chief elements influencing the Climate of Egypt, appeared to have been the sun's heat, the winds, and the River Nile, the two first appertaining to all North Africa, and the latter characterising Egypt and rendering the Delta more tropical and less healthy than the other coast lands.

The French *savants* ascertained the meteorological constants for the city of Cairo at this period to have been these: mean temperature 22°·4 Cent., or 72°·3 Fahr.; mean barometric pressure 761 mm., or 29·96 ins., at a height above sea-level of 18·86 metres, or about 62 feet.

These tables appended show clearly a higher degree of the thermometric mean, 73°·8 McGrigor (74°·7 F. Wittmann), which may be due to a difference of year, the former French figure being for 1798-99, and the latter English figure for 1801-1802, but the barometric mean (29·96 ins. Assalini) is the same for the Delta.

The highest temperatures prevailed in May, June, July, and August, for fourteen days, ranging from 100° to 110° F.; the lowest were in December, January, and February, for 10·7 days varying from 40° to 50° F.; while those of the intermediate months rise and fall between those points.

Temperatures of from 60° to 70° F. appeared on the greatest number of days (95), next those of from 70° to 80° F. were observed on 89 days, while those of 50° to 60° F. were seen on 38 days. For the whole year the most common temperatures of 60° to 90° F. prevailed on 257 days, or about two-thirds of the year, while the uncomfortable extremes of 90° to 110° F. were found on 59 days, and those of 40° to 60° F. only on 48 days. For the years 1798, 1799, Dr. Assalini's tables will enable us to state further particulars as to the meteorological records kept by him, and to calculate that the temperature of air in the morning had a mean maximum of 63°·2, and that at noon the mean maximum was 76°·8. The minimum temperatures at Cairo had a mean of 58°·5 in the morning, and of 67°·3 at noonday, for the year. The barometer had a mean maximum of 30·14 ins., and a mean minimum of 29·75 ins. for the year.

Seasons.—The winter season seemed to have consisted of the months of November, December, January, and February, during which the range of temperature varied between 40° and 80° F., but the greatest average of 60° to 70° prevailed for 59 days. The summer season comprised May, June, July, and August, when the temperatures ranged from 70° to 110° F.; but the greatest average of 80° to 90° F. prevailed for 50 days. During the spring months of March and April a rapid rise of the temperature occurred amounting to 20° F., composed of 24 days of 60° to 70° F. in the first, and of 12 days of 70° to 80° F. in the second month. During the autumn months of September and October a rapid fall of the temperature took place, indicated by 16 days of 80° to 90° F. in the first, and of 26 days of 70° to 80° in the other month.

Remarkable extremes of high temperatures are recorded by Col. R. Wilson

in the summer months, but scarcely any of very low ones, though it must have been common enough to have met with frost and ice then, as it is now in the winter months.

During the march of the Indian Forces under Sir David Baird, across the desert from Kosseir on the Red Sea to Kenneh on the Nile, the thermometer rose during the day from 110° to 115° F. in July 1801, obliging the men to march only during the night.

On May 23rd, 1801, there occurred an unusually severe Sirocco storm or Khamseen wind, which was experienced by the British Army under General Hutchinson, in camp at Bischamps, on the banks of the Nile, when the thermometer rose to 120° F. in the shade. At the same day at Belbeis, on the Ismailia Canal, where the Turkish Army was encamped, it rose to 130° F., but at the British camp near Alexandria it showed 105° F. only, owing doubtless to the proximity of the sea and lakes.

The *chief winds*, which were from the North-west, and called the Etesians or Mediterranean Monsoons, prevailed for 80 days, during the summer months of May, June, July, August and September, and during the whole year for 132 days.

The chief winds in the winter months were—in November, North-west for 14 days; in December, North for 10 days; in January, North-east for 8 days; and in February, North-west for 11 days.

The hot winds, or Khamseens, prevailed in the spring from the South-west for 20 days, and from the South-east for 6 days, in April and May, and calms were common, for 27 days, in every month in the year except August, but prevailed most in January for 6 days, and November for 7 days.

The greatest variety of winds occurred in February and May, when they blew from all points of the compass; and they varied least in September and October, when winds from the North-west and North-east only were observed.

The North-west Monsoons were steadiest in July, when they were observed for 27 days out of the 31. The North winds were most noticed in October. when they prevailed for 22 days, the North-east winds in June for 12 days, The warm Southerly winds had their maximum in 5 days in January, but in November and December they are cold and raw, as they pass over the inundated country when the Nile is in flood, and become charged with moisture.

The South-east winds have their maximum of 2 days in March, when they are hot and dry, as the country is then parched up, the waters of the Nile being at the lowest; and they constitute the Khamseen storms chiefly.

The Easterly winds had their maximum of 2 days in May; the Westerly winds theirs of 6 days in April; and the South-west winds theirs of 6 days in February.

During the whole year there were 132 days with North-west Monsoons, 75 days with North winds, 52 days with North-east winds, making a total of 259 days, or about ⅔ of the year, with winds from the North quadrants, the majority of which again were cooling sea breezes.

Winds from the South, South-west and West prevailed on 61 days, and

from East to South-east on 17 days, or from the most disagreeable direction, which appeared thus reduced to about $\frac{1}{21}$ of the whole year.

The *Rainfall* was estimated by the number of days of rain, and the total of these for the year (Wittmann, 1801-2) was 34, which occurred during the winter and spring months only, when the greatest number of wet days was 12 days for February, and 10 days for March, and the least being 1 day each for April and December.

The Rainfall does not seem to have been recorded by Desgenettes or by Assalini.

The degree of Relative Humidity, recorded by Nouettes in Desgenettes' work, was found to range from 60·9 in winter, January, to 40 in summer, May, coincident with the flow and ebb of Nile floods from the flat lands of the Delta.

The *Barometer* did not seem to have been affected by the change of seasons or weather, as it did not vary more than 0·5 in. from the maximum of 30·37 ins. in January, to the minimum of 29·84 ins. in May, notwithstanding the moisture and aridity of each of these months respectively, and the general mean for the year was 29·96 ins. This may be conjectured to be due to the country lying within the range of the latitudes of 30°-40°, of the Calms of Cancer, where the mercury rules high, and is at the same time steady and undisturbed by storms. The mercury rose above 30·00 ins. in every month except May, in spite of the rains of winter, and reached the lowest point of 29·84 ins. in January, March, May, July, August and September, when the heat was greatest and the air quite dry.

The *Nilometer* or Meekyas of the Cairenes is situated on the Canal at Old Cairo, and indicated that the River Nile rose to its highest point of 31·3 Paris feet, or 33·38 English feet, in the middle of October, and sank to its lowest point of 5·8 Paris feet, or 6·07 English feet, in the middle of June.

The waters thus occupied four months in rising and eight months in falling at the city of Cairo, the climate of which would be thus rendered semi-tropical in the autumn, and semi-temperate in the spring, by the change in volume of the river increasing and diminishing the atmospheric moisture.

The Summer was therefore the driest period of the year, being without either rain or flood to moisten the air or lands; but compensation was provided by the *Etesian* winds then prevailing, which brought up vapours from the Mediterranean seas, and deposited them on the Delta as heavy dews.

It might have been supposed that these winds would have been able to provide enough aqueous vapour to form rain, but it will be seen that the temperatures of 80°-90° and of 90°-100° F. in the day time, co-existing with a dry and glistening land reflecting the sun's heat, would be sufficient to maintain the vapour in the air. It would only have a chance of becoming condensed when the sun was withdrawn and darkness set in with a clear sky, accelerating radiation, and rapidly lowering the temperature of the air beneath.

The occurrence of rains during the winter months would seem to be due to ordinary causes, as there would then be plenty of moisture in the air from

the flooded Nile, and the increased range of temperature would be sufficient to cause larger variations in the capacity of the atmosphere to hold aqueous vapour derived from the river and seas.

Mortality.—It is interesting to observe that Necrological Registers were kept of the mortality of the City of Cairo by its Arab authorities previous to the French invasion, extracts from them being found in Dr. Desgenettes' work on the *History of the Army of the East*, and also in the great French work called *Description de l'Egypte, Etat Moderne, Paris*, 1810-1812. These tables afford means of calculating the rates of mortality of the civil population of that place per 1,000 per annum for every month in the year 1800-1, and comparing them with the high rates of deaths prevailing in the troops at the time campaigning in the Delta of Egypt.

The total deaths were $\frac{8666}{8576}$, and the population was estimated at 260,000, and of these deaths there were $\frac{4874}{4824}=56$ per cent. children, $\frac{2166}{2144}=25$ per cent. females, and $\frac{1624}{1608}=19$ per cent. males, that died of disease, and probably were publicly buried in the town cemeteries outside the city. These figures will give rates of 31·8 or 32 per 1,000 per annum for the total, $\frac{18\cdot7}{18\cdot5}$ for the children, $\frac{8\cdot3}{8\cdot2}$ for the females, and $\frac{6\cdot2}{6\cdot2}$ for the males per annum, all rather low rates for Eastern cities, but showing, however, the inherent healthiness of the locality, in spite of its insanitary conditions.

The highest monthly rate per 1,000 per annum was for April 79·2, when the plague and small-pox were raging in the town, and the lowest was 18·0 in July, the Etesian season, when the Nile was low, and the country dry; showing that the causes of native mortality have little connection with the salubrity or otherwise of the climate.

The *seasons of the year* have been very strikingly rendered by Baron Larrey in his treatise on "Classification des Saisons de l'Egypte," which divides them into four of three months each—

1st. "Fertile," comprising December (Frimaire), January (Nivose), and February (Pluviose), which are salubrious, the time of harvest, with winds Easterly and Southerly. Mortality 28·8 per 1,000.

2nd. "Morbide," comprising March (Ventose), April (Germinal), and May (Floreal), which is pernicious to native health when Khamseen winds prevail, together with exhalations from cemeteries, plagues, gangrenes, yellow and ataxic fevers. Nile at its lowest in the Delta, winds South-easterly and North-easterly. Mortality 51·6 per 1000.

3rd. "Etesian," comprising June (Prairial), July (Messidor), August (Thermidor), when the season is healthy and favourable for the marching of European troops; Nile in flood, no rain; North-west winds or Mediterranean Monsoons prevail. Mortality 21·7 per 1,000.

4th "Humide," comprising September (Fructidor), October (Vendemiaire), November (Brumaire), an unhealthy season, when ophthalmias, fevers,

catarrhs, diarrhœa and dysentery prevail among Europeans. The Nile flood is then at its highest, and the air is moist, and the land is wet with the inundations and irrigations. Winds are then Southerly and Westerly. Mortality 84·9 per 1,000.

The rates of mortality, as above stated, should probably only apply to the native population of Cairo, and not to the European or military forces of France then occupying the country; the diseases affecting the latter are, however, stated in the table of Larrey's Seasons. Indeed there seems to be no congruity between the numerical rates and the diseases in the tables affecting the French troops, as we find the low figures of 24·2 for September, 22·8 for October, and 27·6 for November, coincident with the prevalence of fevers, diarrhœas and catarrhs in the army.

The native Arab and Coptic populations would seem to have suffered most by death during the spring months of March, April and May, when we find rates as high as 88·6, 79·2, and 42·0 prevailing.

The chief causes of this excess of mortality amongst the natives were then probably the plague and small-pox, low and ataxic fever and ophthalmias were also common, but would have been prevented from attacking the Europeans by the ordinary sanitary regulations being carried out in garrisons and camps. It would seem probable, therefore, that the autumn season was the most insalubrious for the European and the spring for the native, and that the moist season was more prejudicial for the former, and the dry season for the latter, or, otherwise stated, the European prefers dry weather and the African moist for health.

Comparison of the Thermometric Tables of Desgenettes, Wittmann, McGrigor, and Assalini.—These were all taken within the same series of years, 1798 to 1802, at different places in the Delta, and in different years, and also at different periods of the day, and they consequently exhibit considerable discrepancies of maxima, minima, and means, but the ranges of each set approximate tolerably well.

The differences would appear to arise sometimes from the years being not exactly identical, and sometimes from observers using different hours of the day for recording their instruments. Desgenettes' observations were sometimes taken at sunrise or at 6 or 8 a.m., and at 12 noon or 2 or 3 p.m., and again at 6 or 8 p.m.

Assalini's observations were connected with Cairo chiefly, but the records do not appear to have been taken with very fine instruments.

Wittmann's periods were more regular and persistent than the others, viz. 8 a.m., 2 p.m., and 6 p.m., adhered to throughout the service, and are more to be relied on than those of the other observers, as are also his tables on the prevalent winds.

For these tables appended, midday observations are put down for maxima, morning observations for minima, and evening observations for means all through, and all the years and parts have been thrown in together so as to get general means, ranges, and totals for one year only.

Desgenettes' mean maximum for the three years (1798-1802) was 80°·4;

Wittmann's (1801-1802) 81°·0,—very near; but Assalini's (1798-1799) was only 76°·25—much less; the respective ranges, however, were nearly analogous, viz. 80°, 36°, and 27°, except the last, which was 52°.

Desgenettes' mean minimum for his three years was 61°·7, which like the former were means of Wittmann's 68°·6, and Assalini's 53°·6; while the respective ranges approached pretty near each other, 30°, 35°, 31°, again showing a mean for the Desgenettes series.

In the general means Desgenettes' lies again between Wittmann's and Assalini's by 72°·6 and 73·°8 to 74°·7 and 65°·3, the last being very low. The ranges also place Desgenettes and McGrigor midway between the other two by 29° to 34° and 26°, Assalini's figures being again lowest.

Climatic Zones of the Delta of Egypt.

In the isobaric charts of Buchan, Mohn, and Scott for the winter month of January the Delta lies between the curves of 30·00 ins. and 30·10 ins., a zone of high pressure extending over the Mediterranean and Red Seas at its upper parts and North Africa.

In the summer (July) Egypt lies between the lines of 29·7 ins. and 29·9 ins., a zone extending over Central Africa and Caspian Seas to the North-east, and within the area of barometric depression in Africa.

The zone of North tropic high pressure of the air on the Eastern continents exists only during the winter months, when it spreads over oceans as well as across land, and along parallel latitudes above the Equator. In the summer it is broken up, and is transferred to the South tropic zone, where it is winter, and then spreads out at that time over both oceans and lands, as in the northern winter along like parallels below the Equator. Therefore in winter Egypt lies in the north tropic zone of aerial high pressure, but in summer it lies in the north continental areas of low pressure.

Isothermals.—In January (winter) Egypt lies between the 50° and 60° zone, extending over North Africa and the Mediterranean. In July (summer) Egypt lies between the 80° and 90° zone, extending over North Africa and the Mediterranean, so that the Egyptian isothermals are more fixed than the isobaric zones.

An inspection of these Meteorological Charts, for the object of considering the relation of the prevailing winds to the bearings of the zones of high barometric pressure or otherwise, will show that some unrecognised discrepancy exists.

The extension of summer Monsoons from the North-west in July would appear to be an effect of the air blowing from a slope of high pressure of 29·9 ins. to a low one of 29·7 ins. further south in Central Africa.

The absence of rain and the low humidity in July will coincide with the dense dry air travelling south, and gathering more moisture as it becomes more rarefied by the severe heat prevailing towards the tropics.

In the winter month of January the prevailing winds from South to West and North would seem to be blowing against the slope of the isobaric hill lying to the North-east, from 30·0 ins. to 30·1 ins., so that it will require some other theory to account for their presence at that month.

TABLE I.—METEOROLOGY OF THE DELTA OF EGYPT, ANGLO-FRENCH CAMPAIGN, 1798-1802.

Month.	Barometer, Assalini. Sep. 1798. Sep. 1799. Max.	Min.	Mean.	Hygrometer—Nouette.	Winds—Wittmann—Delta, &c. April 1801.—April 1802. Days.	SW		NW		NE		SE	Calms.	Max.	Winds, Assalini. Sept. 1798. Sept. 1799. Mean Direction.	Rain, Wittmann. April 1801. April 1802. Number Days.	Nilometer, (Cairo.) 1800. Eng. Feet.	Mortality per 1000. 1799. 1800. Natives. (Cairo.)	Seasons. Larrey. Mortality.
	ins.	ins.	ins.																
January ..	30·370	29·842	30·106	60·9	5·3	3·7	1·7	8·	3·7	2·3	..	..	6·3	NW	S to W	2	14·43	31·2	Fertile
February..	30·106	30·018	30·062	..	3·7	5·7	1·	10·7	·7	3·3	·3	·3	2·3	NW	SSE	12	11·24	27·6	28·8 p. 1000
March	30·018	29·842	29·930	..	..	2·	·7	8·3	3·3	11·3	2·3	2·3	·7	NE	E	10	9·99	33·6	Morbide
April	30·194	29·930	30·062	..	..	4·	5·7	6·3	7·	4·	2·	·7	·3	N	SE	1	8·06	79·2	51·6 p. 1000
May......	29·930	29·842	29·886	40·	·3	3·	5·3	7·	3·	3·	6·7	2·	·3	NW	NE	..	7·18	42·	
June	30·194	29·930	30·062	45·	..	..	1·7	13·	1·7	12·	·3	..	1·3	NW	NE	..	6·44	22·8	Etesian
July......	30·194	29·842	30·018	51·	..	..	·7	27·	1·	2·	..	..	·3	NW	NE	..	7·18	18·	21·7 p. 1000
August ..	30·194	29·842	30·018	50·	..	·3	·3	16·3	12·	1·7	·3	..	..	NW	NW	..	16·58	25·2	
September	30·018	29·842	29·930	..	..	..	..	15·7	11·	·3	..	..	3·3	NW	NE	..	30·42	24·2	Humide
October ..	30·018	29·842	29·930	..	·7	..	..	1·7	21·7	5·7	..	..	1·3	N	SSE	..	32·12	22·8	34·9 p. 1000
November	30·018	29·930	29·974	58·	4·3	1·	1·3	13·7	·7	2·	..	..	7·	NW	SE	8	29·83	27·6	
December	30·194	30·018	30·106	60·	7·	·7	·7	4·	9·7	4·3	..	·3	4·3	N	SSW	1	22·35	27·6	Fertile
	30·14	29·75	29·95	58·	21·3	20·4	10·1	131·7	75·5	51·9	11·9	5·3	27·4	NW	NE	34	17·69	31·8	

TABLE II.
TEMPERATURE OF THE DELTA OF EGYPT, ANGLO-FRENCH CAMPAIGN, 1798-1802.

TABLE III.
METEOROLOGY, DELTA OF EGYPT.

Month.	Nouette. Desgenettes. July 1798.—April 1801. Max.	Min.	Mean.	Assalini. Sept. 1798.—Sept. 1799. Max.	Min.	Mean.	Wittmann. April 1801.—March 1802. Max.	Min.	Mean.	McGrigor. June 1801.—June 1802. Max.	Min.	Mean.	Rain. Days.
	°	°	°	°	°	°	°	°	°	°	°	°	
January ..	65·36	46·33	57·82	66·	53·	55·	66·5	50·1	58·8	70·	60·	65·	11
February	64·21	50·13	59·50	62·	41·	52·	63·5	51·3	58·	63·	55·	59·	19
March....	69·10	50·10	66·40	62·	53·5	57·7	68·2	62·3	64·5	69·	50·	60·	12
April	90·50	65·37	77·93	85·	50·	69·	82·4	67·	73·8	71·5	60·	65·7	15
May......	90·97	67·60	79·28	90·	61·5	75·6	94·5	77·3	85·1	98·	60·	79·	—
June ...	94·77	71·19	83·20	88·5	62·	77·7	99·8	81·8	89·1	114·	69·	91·	—
July......	91·04	75·23	86·70	89·	53·	74·6	99·6	84·9	92·5	115·	70·	92·	—
August ..	90·02	76·81	85·94	84·5	68·	77·2	91·6	81·3	86·7	90·	80·5	85·2	—
September	81·11	70·88	77·10	76·	65·	75·5	86·2	77·3	81·8	83·5	73·	78·2	—
October ..	77·47	65·44	73·02	72·	50·5	61·	79·5	74·7	77·7	80·	69·5	74·7	—
November	71·14	54·87	64·78	68·	49·	57·5	71·2	59·6	66·1	77·	57·	67·	15
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	70·	49·	59·	1

The occurrence of rain then, and a higher relative humidity of the air, very probably indicate that these winds are equatorial, and that Maury's views on the circulation of the atmosphere might better explain their appearance, as being a strip of the passage winds that had come down after the crossing of the winds at the tropic line of Cancer. Probably, however, the greater or less humidity of the air of the Delta of Egypt depends much more on the flooding or ebbing of the River Nile, the one in January and the other in July, than on extraneous agencies.

[NOTE added November 1884.]

The Thermometric Table of Dr. J. McGrigor, Chief Medical Officer of the Indian Army in Egypt, is one compiled from the text of his narrative, and the means are all calculated from the other selected data.

The mean maximum, 88°·4, is higher than that of the other tables; the mean minimum, 62°·8, is close upon that of Wittmann's, and the total mean, 73°·8, is nearly the same also as his.

The maximum range, 52°, is, however, much greater than any of the others; but the minimum range, 31°·5, and the mean range, 33°, nearly approximate to those in the other tables.

His highest maximum, 115°, July, is much higher than any of the others, and the lowest minimum, 49°, December, is intermediate to the others; but the mean highest, 92°, July, and mean lowest, 59°, February, were nearly the same as those of Wittmann.

Dr. J. McGrigor further records 73 days on which *rain* fell in the year 1801-2 during the six months of winter and spring, more than double the number observed by Wittmann, 34, in the same period, though it occurs in similar months in both sets of observations.

This marked difference of rainfall was probably due to the observers' entering Lower Egypt from opposite directions, the one from Nubia in the South, and the other from Syria in the North, and thus travelling over different regions to Cairo.

The table of winds given by Assalini shows a greater prevalence of easterly winds than does Wittmann's, which may be due to a difference of years, and also to the former being noted for Cairo, and the latter for the Delta generally.

PROCEEDINGS AT THE MEETINGS OF THE SOCIETY.

MAY 21ST, 1884.

Ordinary Meeting.

ROBERT H. SCOTT, M.A., F.R.S., President, in the Chair.

Capt. WILLIAM WATTS HAMPTON, 13 Austin Friars, E.C.; and
CHARLES DOUGLAS FERGUSSON PHILLIPS, M.D., F.R.S.E., F.R.C.S., 10 Henrietta Street, Cavendish Square, W.,
were balloted for, and duly elected Fellows of the Society.

The following Papers were read, viz.:—

"NOTES ON THE PROCEEDINGS OF THE INTERNATIONAL POLAR CONFERENCE, HELD AT VIENNA, APRIL 17TH-24TH, 1884." By ROBERT H. SCOTT, F.R.S., President.

THE Fellows need hardly be reminded that it was at the suggestion of an Austrian, the late Carl Weyprecht, that this great international undertaking was set on foot, and accordingly Vienna was the most fitting city in which to welcome the several expeditions on their return to civilisation, and to discuss the best mode of utilising their labours.

The chiefs of nine expeditions were present at the meeting. The unrepresented stations were the two Russian ones, at Nova Zembla and at the mouth of the Lena (at which latter station the observations will be continued until August 1884); that established by the Society of Science of Finland, at Sodan Kyla; the German station in South Georgia; and the second American station at Lady Franklin Bay. As to the fate of the observers at the last-named locality, there are, unfortunately, grave reasons for anxiety.

Most of the expeditions had brought home a collection of photographs, giving a vivid representation of their respective surroundings during their sojourn. Many of these possess ethnological interest, and one was humorous, as it showed the Dutch Arctic Tin-Band, with instruments made out of preserved meat canisters.

I suppose the Fellows are aware that the Dutch Expedition was ice-bound and drifted about in the Kara Sea, ultimately saving itself in its boats. The ship was crushed in the autumn of 1882, but did not actually sink for six months, so that all the property was saved. Under such circumstances, however, it is no wonder that no magnetical observations were made.

As regards the Publications. These are to be carried out independently in each country, but on an uniform plan; the meteorological observations to be given in metric and centigrade measures, the magnetical according to the C.G.S. system of units.

The hourly observations are to be published in detail. The barometer observations are not to be corrected to gravity of 45°, but the value of this correction is to be given in the tables.

As regards Terrestrial Magnetism, besides the publication of the Term Day Observations a detailed reproduction of all the observations for certain days of disturbance is to be given. A list of these days will be prepared by Prof. Wild.

All the Members of the Conference are requested to collect data for earth currents for their respective countries during the period of the circum-polar observations. The auroral observations to be published on the scheme proposed by Weyprecht.

As to the magnetic disturbances and their elimination, there was, as might be expected, a long debate, but no definite resolutions were adopted.

The publication of a number of observations was left optional—such as evaporation; solar radiation; the resolution of the wind to four components; the calculation of the wind roses according as the pressure was above or below 760 mm., &c. &c.

It is hoped that the whole of the results will have appeared by the end of 1885.

The Conference was most graciously received by the Emperor at an audience. The members were also entertained at a magnificent banquet on April 23rd by Count Wilczek, at whose sole expense the Austrian Expedition to Jan Mayen had been fitted out and maintained during its stay.

DISCUSSION.

Capt. P. H. RAY, U.S. Navy, at the request of the President, said:—The expedition which I had the honour to command was one of the International Polar Expeditions sent out by the United States in 1881. The second one from that country, under command of Lieut. Greely, reached its destination, Lady Franklin Bay, in August of that year, since which time there has been no communication with him, so the result of his work is unknown.

The party under my command sailed from San Francisco on July 18th, 1881,

and reached their destination, Point Barrow, Alaska, September 8th, 1881, where the permanent station was established within a few miles of the little harbour where H.M.S. *Plover* wintered in 1852-3-4, in lat. 71° 23′ N., long. 156° 37′ 45″ W. The meteorological conditions of that latitude are no more startling in their results than changes we have in the lower latitudes, and as a rule the Arctic is quite free from violent gales and great ranges in temperature; and though our annual mean was 7° and the highest recorded temperature was 50°, we never suffered from cold, owing to the fact that the daily range was so small. When the temperature was ranging between —30° and —56° (which was the lowest recorded) we rarely had a daily range of over 7°.

The temperature in the office and living room was kept above 60° without any difficulty with an ordinary gas burner stove, and although all the members of the party were out in the open air from one to four hours each day, "except when prevented by gales," they suffered but very little from frost bites, and never had a single case while travelling, when we were exposed constantly. Once each year, towards the end of January, we experienced a very severe gale; the first winter a movement of 128 miles per hour was recorded before the anemometer was carried away, and the second winter the anemometer broke when the gale had attained a velocity of 100 miles per hour.

It is extremely difficult to describe the effects of a gale of this character; they commenced in the same direction both years, that is from the South-south-east, and gradually hauling to the West-south-west, gradually increasing in violence, and blew out at the latter point, lasting altogether about fifty hours. The air was filled with flying sand and gravel from the adjacent beach, and it was impossible for any living thing to stand before it. I have no doubt our house would have gone had it not been so firmly anchored by the hard frozen snow that had been drifted around it; for where the rough weather-boarding was exposed above the snow it smoothed off as though a plane had been run over it, and the glass dial of the anemometer was ground, so the instrument could not be read, though it was 100 yards back from the beach and forty feet above the surface of the earth. The temperature rose rapidly from about —30° when the gale commenced, to +18° when it ended. The ice in the open ocean was very much broken, and piled from forty to sixty feet high, where the pressure set in on the western shore.

During the time the station was occupied a shaft was sunk to a depth of thirty-nine feet for the purpose of getting the temperature of the earth: at this depth we got an unvarying temperature of 12°, and from the ratio obtained we found the earth was frozen to a depth of nearly 300 feet at this point, and at a depth of twenty-six feet a pair of wooden snow goggles were found; they were of the same pattern as those worn by the Esquimaux now inhabiting this coast; the point where they were found was fourteen feet below the level of the sea.

The auroral display was remarkably brilliant, occurring nearly every night, commencing about 4 p.m. and continuing through the whole night, gradually fading away between 3 and 5 o'clock in the morning: it was always a brilliant flashing light, changing rapidly, at times taking the form of a curtain and at others the form of a corona in the zenith. We never saw it take the form of the bow and arch so often described in other places.

The party was so fortunate as to be able to return to the United States without the loss of a single man, having accomplished all they were sent to do.

Mr. WHIPPLE inquired whether Captain Ray had observed if the Aurora was accompanied by the hissing sound attributed to it by many Arctic travellers.

Commander HULL remarked that he was very pleased to have met Captain Ray, and to have heard him give such an interesting account of his work in the Arctic Regions. Captain Ray had described himself as a poacher, he trusted Captain Ray would continue to poach: the game in question truly was plenteous, but the hunters few. Captain Ray's experiences of Point Barrow were in every particular curiously the same as his own. Whether the matter treated upon was men or women; wind, weather, or magnetism; or the formation and movement of ice, he could make no addition to the terse and lucid statements of Captain Ray. In 1881-2 similar magnificent auroral displays were constantly seen as in 1852-3, with like remarkable effect upon the magnetic needles, but quite unaccompanied by sound. It was with great pain and regret that he heard of the diminution in numbers of the interesting people of Noowook (Point

Barrow). From 309 in 1853, the population had dwindled down to about 160 in 1882. There is but little doubt that the reason for this reduction is famine, caused, it is to be feared, by the whales having been driven away from the vicinity of Point Barrow by enterprising whalers; for in 1852 no less than seventeen whales were captured by the natives, while in 1882 only two were taken.

"METEOROLOGICAL OBSERVATIONS ON THE MALOJA PLATEAU, UPPER ENGADINE, 6,000 FEET ABOVE THE SEA." By A. TUCKER WISE, M.D., F.R.Met.Soc. (p. 213.)

"SOME RESULTS OF AN EXAMINATION OF THE BAROMETRIC VARIATIONS IN WESTERN INDIA." By A. NAYLOR PEARSON, F.R.Met.Soc. (p. 219.)

"ILLUSTRATIONS OF THE MODE OF TAKING METEOROLOGICAL AVERAGES BY THE METHOD OF WEIGHING PAPER DIAGRAMS." By RICHARD INWARDS, F.R.Met.Soc., F.R.A.S.

IN endeavouring to ascertain, say, the average temperature of the air during a whole year, the mode sought should be one which would include every fraction of a degree and every minute of time. This by mere arithmetic may be considered as practically unattainable.

But if we take the weekly diagrams, such as those of the Kew observations, printed in the *Times*, and after cutting out each week's diagram, divide it carefully along the temperature curve, and placing all the lower parts so cut off in the scale of an accurate assay balance, it is clear that the weight of these parts, as compared with the whole weight of the uncut diagrams, will be in the same proportion as is the average temperature to that which would have been indicated by a straight line along the top of the diagram. It is of course necessary to add the number of degrees with which the scale commences at the base.

Precautions must be taken to have the paper of uniform thickness, and for this purpose it is better in practice to trace the original diagrams upon slips all cut from one large sheet of paper, as it will be found that the different parts of one sheet do not vary so much in weight as do slips cut from several sheets. Small inaccuracies in this matter do not greatly affect the average result, as of course the two parts of the diagram are equally affected by the varying thickness. In the matter of temperature it is safe to say that the third place of decimals only would be influenced by this cause.

The barometer and wind-curves may be treated in the same manner, and I append the results of weighing the Kew diagrams for 1883, as given in the *Times Register of Events* for that year.

Average temperature, 49°·908.

Average height of barometer, 29·929 ins.

The analysis of the wind-curves by the same method is also given in the following table. There is, however, much more uncertainty about these results, on account of the small size of the diagrams, and from other causes.

Direction of Wind.	Number of Days on which it blew.	Hours.	Average Rate in Miles per hour.	Total Hour-Miles.
Between N and NE	31·447	754·73	12·218	9,221
„ NE „ E	36·811	883·46	11·667	10,307
„ E „ SE	29·143	699·43	9·237	6,461
„ SE „ S	17·732	425·57	13·26	5,643
„ S „ SW	63·12	1,514·88	12·31	18,648
„ SW „ W	111·504	2,676·1	10·954	29,314
„ W „ NW	56·338	1,352·11	9·053	12,241
„ NW „ N	18·905	453·72	9·709	4,405
North Quadrant	50·352	1,208·45	..	13,626
East „	65·954	1,582·89	..	16,768
South „	80·852	1,940·45	..	24,291
West „	167·842	4,028·21	..	41,555

This shows an excess of 35,452 hour-miles in a South-westerly direction, an mount which, taken over a breadth of 200 miles, corresponds to the movement f a weight of air of about 185 (English) billions of tons.

A similar method to that just described may also be applied to ascertaining he average level of any section of the country from a scaled drawing, and also finding the areas of sun-spots by having them photographed to the same scale nd then cutting them out and weighing them in comparison with a measured iece of the photographic paper.

DISCUSSION.

Mr. WHIPPLE said that the method described by Mr. Inwards was not new, ut had been used by various physicists for measuring curves. Prof. B. Stewart nd Mr. Gee had recently been working at this subject in connection with a book hich they were preparing, and the results of their experiments showed that this lan of obtaining mean values was very fairly accurate, the errors being small, ss than 1 per cent., and comparable with the degree of accuracy given by an *msler's* Planimeter.

Mr. INWARDS remarked that he was not aware that this method had been used the manner described by Mr. Whipple.

"TEN YEARS' WEATHER IN THE MIDLANDS." By RUPERT T. SMITH, .R.Met.Soc. (Abstract.)

HE author in this paper gives tables of observations which have all been ade from the records kept at four stations, all situate in the Black Country, nd distant from Birmingham from three to ten miles in a westerly direction.

The records were begun in January 1874, and from March of that year they ere, with very occasional lapses, continuous and complete; the solar radiation nd grass minimum thermometer readings, however, were not commenced until pril.

The rainfall and mean temperatures of the first three months of 1874 have een taken from observations made at another station in the immediate neighourhood of Birmingham.

The district under discussion is the part of South Staffordshire and North Vorcestershire contiguous to the Rowley Hills, forming the North and South ange of the main water-parting of England; these hills extend from Bromsrove to beyond Wolverhampton. One of the stations at which observations ere made is situate at Round Oak, two miles to the south-west of Dudley, and n the west side of the backbone of hills, a position lying fairly open to the outh and the valley of the Severn. Another station was at Turner's Hill, pon the highest point of the Rowley Hills, two miles south-east of Dudley. he other two stations were at West Bromwich and Handsworth, being upon he east side of the Rowley Hills range, situated upon minor hills at the emouchure of the catchment basin of the upper valley of the river Tame. The xtreme difference of altitude is 378 feet; the westernmost station being 501 feet nd the hill station 879 feet above sea-level. The station at Round Oak was pon the clay of the Coal Measures; that at Turner's Hill upon the basalt; that t West Bromwich upon the upflow just off the coal clay Primary; and that t Handsworth on the Bunter Conglomerate, just off the belt of a New Red Sandtone that fringes the eastern and western sides of the coal field.

The instruments used were all good, and made by Hicks. But as they ave not been compared since 1876, it is probable that the thermometers are ading too high.

At Brierley Hill the instruments were placed in the centre of a fair-sized arden and free from trees. The shaded thermometer faced north-east, with a ood position.

At Rowley Regis the instruments were placed in the centre of a small grasslot on the west side of a house, and about eighteen yards distant. There ere some trees in the neighbourhood at about the same distance, subtending an ngle of about 30°. There was also a plane tree fifteen feet to the north-northest, which was close cropped. The rain-gauge was three yards only from the hermometer screen, which at this station faces north-east-by-east. The poition was only fair.

At West Bromwich the shaded thermometers were placed upon a party wall facing west by compass, but protected from sunshine by buildings distant therefrom about twenty feet only. The black-bulb radiation thermometer, grass minimum thermometer, and the rain-gauge were fairly well exposed in a small back garden, and free from radiation. This was a bad position.

At Handsworth the thermometer screen faced due north in a garden sloping to north-north-east. The exposure was good. The rain-gauge was about ten feet on the west side of the screen. This was a good position.

The screens used (except at West Bromwich) were Sir H. James's pattern. The rain-gauge had a diameter of 5 ins., and was 4 ins. above the ground.

The author gives the tables of mean results for each month during the ten years, and also of the hot and warm days, and the cool and cold days, &c. The average temperature, rainfall and number of wet days are as follows :—

AVERAGE FOR TEN YEARS, 1874-1883.

MONTH.	TEMPERATURE.	RAINFALL.	NO. OF WET DAYS.
	°	Ins.	
January	36·3	2·39	14
February	38·6	2·58	17
March	40·0	1·63	13
April	46·1	2·11	14
May	51·5	2·46	14
June	58·5	2·94	15
July	61·1	3·41	16
August	59·8	3·45	16
September	54·9	3·39	16
October	47·4	3·36	17
November	40·7	3·00	18
December	36·5	2·53	16
Year	47·6	33·25	186

One of the chief deductions to be drawn from an inspection of the tables is this the marked difference in the two halves of the decade as regards temperature and rainfall, dividing the period into two *lustra;* the first period of five years being generally hot and dry, and the second cold and wet. The difference of temperature is observable in the spring, summer and autumn, but not in the winter, the winters of 1874-1878 being decidedly colder than those of the years 1879-1883.

The tables of rainfall and wet days show the two *lustra* to be respectively dry and wet; for while the springs show about an average rainfall, the summers, autumns and winters of the first *lustrum* show a deficit, whilst the second is correspondingly in excess of rainfall. The table of wet days is of service in showing the successively bad springs for the farmers' sowings of the years 1876-1879, although the number of wet days appears to be no criterion of the actual amount of rainfall.

To sum up these, the seasons of the year 1874 in this portion of the Midlands were both hot and dry; 1875 was of average temperature and dry; 1876 was warm, and an average rainfall; 1877 was of average temperature and dry; 1878 was cold, with an average rainfall; whilst the years of the second period were, in 1879 cold, with an average rainfall; 1880 cold, with an average rainfall; 1881 cool and an average rainfall; 1882 cool and very wet; and 1883 cool, with an average rainfall.

Comparisons with temperature observations in the neighbourhood point to the conclusion that the error due to the high reading of old thermometers does not exceed 0°·3.

JUNE 18TH, 1884.

Ordinary Meeting.

ROBERT H. SCOTT, M.A., F.R.S., President, in the Chair.

DR. BENJAMIN A. GOULD, Director of the Observatory of Cordoba, Argentine Confederation, was balloted for and duly elected an Honorary Member of the Society.

The following Papers were read, viz.:—

"THE EQUINOCTIAL GALES—DO THEY OCCUR IN THE BRITISH ISLES?" By ROBERT H. SCOTT, M.A., F.R.S., President. (p. 236.)

"ON THE PHYSICAL SIGNIFICANCE OF CONCAVE AND CONVEX BAROGRAPHIC AND THERMOGRAPHIC TRACES." By the Hon. RALPH ABERCROMBY, F.R.Met.Soc. (p. 241.)

"MARITIME LOSSES AND CASUALTIES FOR 1883, CONSIDERED IN CONNECTION WITH THE WEATHER." By CHARLES HARDING, F.R.Met.Soc. (p. 250.)

"THE HELM WIND." By the Rev. JOSEPH BRUNSKILL, F.R.Met.Soc.

THE Helm, as one of Professor Ruskin's "plague winds," is most notorious on the Cross Fell portion of the Pennine range. There it is accompanied with a roar distinctively awful in its warnings to the dwellers within the stormy influence. The name 'Helm' is applied to the effects of the wind, and is, I believe, the old word by which our Cymry ancestors described the round mountain now called Cross Fell. Generally there is a long white cloud named the 'Helm Bar,' hanging opposite to the fell-side at a distance varying from one to several miles. Beyond the bar the sky is clear, excepting the broken fragments of cloud driven across, and a white cloud resting on the helm or stack-like top of the mountain. Where the mist is resting there is calm, but the observer on walking a short distance enters the wind, which may be what Professor Ruskin calls "a cyclone inside out or outside in." A wind with the same cloud formation and general characteristics is common among the Cumbrian fells, and probably exists wherever there are mountains a few miles inland from the sea.

In Cumberland a helm wind often coincides with an anticyclone in the North Atlantic near our coasts, and is generally without rain.

It is probable that the Helm Wind comes down Cross Fell and Blencathra with a dropping rush (*sic*) as direct as a falling rock, and the belated traveller must cling to any thing earthfast. On the wide top of Cross Fell or along its eastern slopes the storm wind is seldom felt; but much has been written about its overwhelming fury along the western base. I knew its lifting force during some years at Milburn, and remember the schoolboy's defence of tying down his cap. The noise of the Helm Wind is peculiarly distant, as "when thou hearest the sound of a going in the tops of the mulberry trees" or like the breakers rolling in from the Atlantic upon loose shingle. This roar I have heard at Lowther an hour in advance of the

storm coming over the Lake mountains from the West, and before the detached scudding clouds were visible; and with the whirling sensation and piercing cold I recognised the Helm in Plumpton, where crossing the Eden valley it sometimes rushes through the gap at Scratchmere Scaur; yet the residents along those few miles in the Petteril Valley never remarked upon the phenomenon, although the dry storm would stop haymaking.

However, the Helm Wind seldom extends in force across the river Eden, though I have been within its influence westward of Julian's-bower. Even there a rider must do all that he knows, especially at gates; for I believe that any vehicle would be soon wrecked. I once happened to cross from Crosby Ravensworth over the Scaur to Asby, when the Helm was described as having burst, *i.e.* the cloud bar above was dispersed, and the wind reached further westward. On that desolate height, with premature darkness, increasing cold, and the terrible howl of the wind, I was thankful to overtake two men returning from their work, and escape by their guidance, else I might have been 'lost' there at least for the night, as they had been shortly before. Long years afterwards, perhaps led by these experiences to observe, I have more than once concluded from the bend in the helm-bar that the storm wind was apparently being felt in Penrith, and by going there (five miles) have verified the disagreeable fact.

Sometimes there is a second cloud called the "Helm Burr," further back and higher than the ordinary beautiful Bar. From the elevation of Hackthorpe I have had very fine opportunities of admiring at that safe distance an Eastern Helm, which term I would use for distinction from a similar Helm Wind in "Wordsworthshire."[1] The huge and solemn bar is visible for thirty miles, apparently suspended at the same level. The higher and western sides might be brightly beautiful, but looking under the luminous mass we could see a dozen miles east where its dark shadow lay fixed and determined, "and where the wind was blowing indifferently from all quarters in malice and bitterness." Sometimes in a darker and more terrible Helm we knew that there was a gale beyond the Pennines, imperilling 'lives and men' fishing in the North Sea. More recently I have stood on Blencathra, 2,847 feet above sea-level, in a piercingly cold East wind, and seen the same solemn bar hanging in a grand circle that included Skiddaw, Grisedale, Coniston, Helm-crag, and Helvellyn. And often from the shelter of St. John's in the Vale I see grand effects in cloudland similar to those lately described most graphically by a special correspondent writing from the West Highlands to the *Glasgow Evening News*:—"For several days a great mass of clouds had lain across from Ben Breac to the head of Glen Creran, in an immovable bank, while the storm had been raging both above and below. Suddenly a light cloud, advancing from the South-east, was found to be gyrating, not vertically, but horizontally, as if an irregular roller had been dragged across the sky, the revolutions being frequent, turbulent, and extending for a considerable distance. Later in the day,

[1] "Wordsworthshire" is a fanciful name for the English Lake district. ED.

rards Glenure, we observed what seemed explanatory—a stiff gale was wing from the South-east above the bank of clouds before mentioned, ipping off the edges and whirling them outward away from the mountain s, while another gale, more Southerly, but apparently blowing under the ud bank, met the patches at an upward tending angle, given by the untains it had met and slanted over, and thus they were carried across sky in the embrace of the horizontally cyclonic breeze. The sky was y disturbed, and seemed to point to severe gales, turned in different ections from the mountain range stretching from Conachan to Glencoe; t as to why the great bank of cloud should have so long remained outside ir influence we could not satisfy ourselves."

DISCUSSION.

The PRESIDENT (Mr. SCOTT) read the following letters, which he had received om the Hon. E. Ashley, M.P., relative to winds experienced on the slopes of n Bulben, Co. Sligo, and also from Dr. J. Hann, Hon. Mem. R.Met.Soc.

Mr. ASHLEY wrote:—" The wind to which I referred comes from the East. s great violence I attribute to the conformation of the hills from which it mes. There are gorges where it gets pent up and is then driven with great olence out of the narrow channel—because the nearer you are to the hills, the onger it is, and there are certain spots and corners on the high road where it always stronger than any where else. It is generally worst at the end of nter or beginning of spring, in fact in February and March."

Dr. HANN wrote:—" I have just read Mr. Watson's paper 'on the Helm Wind Cross Fell.' This clearly bears a great resemblance (but only a resemblance) the phenomena of Table Mountain. Herschel also describes the formation of isolated cloud over the centre of the bay on the amphitheatre in which Cape own is situated. Hoffmeyer also once exhibited a drawing by Fritz of the odthaabfiord, where isolated *immoveable* clouds form themselves over the ntre of the fiord at a time of violent storms, very similar to what Herschel scribes in his *Meteorology*.

" I think that these clouds are formed in the ascending portion of a violent aerial sturbance. A storm blowing over high land, especially over an isolated mountain ass, must often generate local eddies, the nature of which will be shown by the oud. In this connection I would remind you of Osborne Reynolds's paper in *ature*, Vol. XXX. p. 88, on the sinuosities in the interior of water or air in otion. I have not been able to follow fully Mr. Watson's description in detail; sketch, no matter how rough, would be of great use. As regards the protracted ration of the Helm Wind, this can only be explained by the general conditions the weather, the direction of the isobars, &c. The local peculiarities must pend entirely on the configuration of the ground, and could only be explained a person who knows the country thoroughly. Anyhow, in my opinion the rmation of cloud indicates an ascensional movement of the air, its dissipation a scending movement. Possibly in the case of the Helm Wind we have vortices ith horizontal axes, just as we have in the case of squalls, where a roll of cloud formed which is very sharply defined."

The Rev. J. AINSWORTH drew attention to the features in common between the elm Wind and that described by Mr. Ashley as occurring on the West Coast Ireland. They were both remarkable for their force, Easterly direction and calised character, but differed in this, that while the wind in the West of Ireland as reported as occurring in February only, the "Helm" was not confined to any riod, though it mostly blew in March and April. The configuration of the land o in both cases, so far as he could make out, was much the same, with the excepon of the greater size and height of the Pennine summit. On the eastern side Cross Fell three rivers had their head waters, and there were numerous valleys which the air could accumulate before rushing out over the mountain top. lost probably the form of the land in the district had much to do with the production of the 'Helm Wind.'

Lieut.-Gen. STRACHEY remarked that wind blowing up the valleys during the day and down the valleys during the night was a very common phenomenon on all mountains, and he had personal experience of it on the Himalaya. As the surface drainage from the mountain slopes collects and flows off through gorges or breaks in the range, so in a similar manner the cold air collects during the night in the mountain valleys, and rushes out through whatever openings may exist in the range. The winds experienced in the mountains in India only blew from the valleys at night time, but the Helm Wind appeared to blow day and night. It was impossible, however, thoroughly to understand the paper without having an exact knowledge of the physical features of the locality, which he did not possess.

The Rev. J. AINSWORTH remarked, that previous to the "Helm" forming, a Westerly wind generally blew, and by means of the black-board he gave some details respecting the peculiar form of the land in the district. He supplied sketches in illustration of the theory that the cold Easterly winds came rolling up the slopes and numerous valleys on the east of Cross Fell, where they met the warm moist winds from the Atlantic westward, and that the "bar" of cloud was the result of condensation. The colder East wind, perhaps thrust to a great height, dropped down the Western slope, while the Western current was turned upward and backward upon itself.

Mr. SYMONS always understood that in most cases the stream of cloud stretched away to the leeward of the mountains, but in the cases of the 'helm bar' it was different, as, unless he was misinformed, the 'bar' was alway parallel to the Pennine chain, and extended from north to south, not from east to west. He might mention that an account of the Helm Wind would be found at pages 58 to 63 of *An Account of the Mining Districts of Alston Moor, &c.* by T. Sopwith. Alnwick, 1833, 12mo.

The following papers are added to make the discussion as complete as possible:—

ON THE HELM WIND OF CROSS FELL. By the Rev. J. WATSON.

(*Report of the British Association*, Vol. VII. Section II. p. 33.)

HELM Wind is a local name of uncertain origin, but generally supposed to be derived from the cloud that, like a cap or helmet, is often seen on the tops of mountains. It is specially applied to a very violent wind, blowing frequently from some Easterly point of the compass, but mostly due East, at the west side of the mountains known by the name of the Cross Fell range, and confined both in length and breadth to the space contained between the Helm and the Helm Bar, hereafter described. Along the top ridge of the mountains, and extending from three or four to sixteen or eighteen miles each way, north and south, from the highest point, is often seen a large long roll of clouds; the *western* front clearly defined and quite separated from any other cloud on that side; it is at times above the mountain, sometimes rests on its top, but most frequently descends a considerable way down its side; this is called the Helm. In opposition to this, and at a variable distance towards the west, is another cloud with its *eastern* edge as clearly defined as the Helm, and at the same height: this is called the *Bar* or *Burr;* the space between the Helm and the Bar is the limit of the wind. The distance between the Helm and Bar varies as the Bar advances or recedes from the Helm; this is sometimes not more than half a mile, sometimes three or four miles, and occasionally the Bar seems to coincide with the horizon, or it disperses and there is *no* Bar, and then there is a general East wind extending over all the country westward. However violent the wind be between the Helm and the Bar, it extends no farther; on the west side of the Bar there is either no wind or it blows in a contrary direction, that is, from the West, or from various points in sudden and strong gusts, when the Bar advances so far as to unite with the Helm; if the Bar disperses, the wind ceases. Neither the Helm nor Bar are separate or detached clouds, but may be rather said to be the bold, clearly defined fronts of bodies of clouds extending eastward behind the Helm, and westward from the Bar. The clouds forming the Helm and Bar

cannot perhaps strictly be said to be parallel; the open space between them may rather be called a very flat ellipse, in which the transverse diameter varies from eight or ten to twenty-five or thirty miles, and the conjugate from half-a-mile to four or five miles; they appear always united at the ends.

This wind is very irregular, but most frequent from the end of September to the month of May; it seldom occurs in the summer months; there was one this year, 1838, on the 2nd of July, and there have been more in the last two years than in the preceding six. Sometimes, when the atmosphere is quite settled, not a breath of wind stirring, and hardly a cloud to be seen, a small but well-known cloud appears on the summit, extends itself to the north and south—the "Helm is on," and in a few minutes blowing furiously, sufficient to break trees, overthrow stacks of grain, throw a person from his horse, or overturn a horse and cart. The Helm at times seems violently agitated, and on ascending the fell and entering it there is little wind, and this sometimes not in the direction of the wind below; one may, in fact, be in the Helm for a whole day without being aware of the wind on the west. The Helm appears sometimes to run or pour off from the highest part, each way towards the north and south points of the junction of the Helm and Bar, and there to be piled up in great masses; occasionally a Helm forms and goes off without a blast. The open space between the Helm and Bar is clear of clouds, with the exception of small pieces breaking off now and then from the Helm and driving rapidly over to the Bar; through this open space is often seen a higher stratum of clouds quite at rest.

Most mountainous countries, particularly where the mountains terminate abruptly, seem liable to sudden gusts of wind, such as occur at the Cape of Good Hope, in Switzerland, and among the lakes of our own country; but the Helm Wind differs from all in respect to the Bar, and that within the space described it blows *continually;* it has been known to blow for nine days together, the Bar advancing or receding, or continuing stationary for a day. When heard and felt for the first time it does not seem so very extraordinary; but when we find it blowing and roaring morning, noon, and night, for days together, it makes a strong impression on the mind, and we are compelled to acknowledge that it is one of the most singular phenomena of meteorology. Its sound is peculiar, and when once known is easily distinguished from that of ordinary winds; it cannot be heard more than three or four miles beyond its limit, but by persons who have stood within the wind or near it, it has been compared to the noise made by the sea in a violent storm, or that of a large cotton mill when all the machinery is going. It is seldom accompanied by rain within the open space, and never continues long after it begins to rain heavily; in spring it is most frequent after rain. The country subject to it is very healthy, but the wind does great injury to vegetation, as it batters the grain, grass, and the leaves of trees till they are quite black. Various hypotheses have been suggested to account for this phenomenon, one of the most plausible assumes that the air is cooled by its gradual ascent from the east coast, and on reaching the summit of the mountains rushes with great force down the western escarpment into a lower and warmer region. In opposition to this, it is stated that the valley of the Tyne, where the Helm Wind is not felt, is not much higher than that of the Eden; and secondly, the wind does not extend farther west than where the bar is vertical, and this is not very often so far as the Eden. The cause, Mr. Watson thinks, must be sought for in that region of the atmosphere extending from 800 to about 5,000 feet above the earth's surface.

A Few Remarks on the Helm Wind. By the Rev. William Walton.

(*Proceedings of the Royal Society*, Vol. III. p. 459.)

On the western declivity of a range of mountains, extending from Brampton, in Cumberland, to Brough, in Westmoreland, a distance of 40 miles, a remarkably violent wind occasionally prevails, blowing with tremendous violence down the western slope of the mountain, extending two or three miles over the plain at the base, often overturning horses with carriages, and producing much damage, especially during the period when ripe corn is standing. It is accompanied by a loud noise, like the roaring of distant thunder: and is carefully avoided by travellers in that district, as being fraught with considerable danger. It is termed the *helm wind;* and its presence is indicated by a belt of clouds,

denominated the *helm bar*, which rests in front of the mountain, three or four miles west of its summit, and apparently at an equal elevation, remaining immoveable during twenty-four or even thirty-six hours, and collecting or attracting to itself all the light clouds which approach it. As long as this bar continues unbroken, the wind blows with unceasing fury, not in gusts, like other storms, but with continued pressure. This wind extends only as far as the spot where the bar is vertical, or immediately overhead; while at the distance of a mile farther west, as well as to the east of the summit of the mountain, it is not unfrequently almost a perfect calm. The author details the particulars of an expedition which he made with a view to investigate the circumstances of this remarkable meteorological phenomenon, and proposes a theory for its explanation.

THE HELM WIND. By T. SOPWITH, F.R.S.

From *An Account of the Mining Districts of Alston Moor, &c.* By T. SOPWITH, Alnwick. 1833. 12mo.

THE Helm wind is a curious local phenomenon, which occurs along several miles of the western sides of these mountains, and to the violence of which the traveller will be occasionally exposed. It derives its name from being accompanied by a long band or cloud stretching like a helmet over the summit of the hills, and occurs more frequently in the spring and autumn than at other times. Its duration is very various, from a few hours to a few days.

The following interesting notices of this singular phenomenon are chiefly extracted from Hutchinson's *History of Cumberland.*

"Upon the summits of this lofty ridge of mountains there frequently hangs a vast column of clouds, in a sullen and drowsy state, having little movement; this heavy collection of vapours frequently extends several miles in length, and dips itself from the summit, half-way down to the base of these eminences; and frequently, at the same time, the other mountains in view are clear of mist, and show no sign of rain. This *helm* or cloud exhibits an awful and solemn appearance, tinged with white by the sun's rays that strike the upper parts, and spreading a gloom below, over the inferior parts of the mountains, like the shadows of night. When this collection of vapour first begins to gather upon the hills, there is to be observed, hanging upon it, a black strip of cloud continually flying off and fed from the white part, which is the real Helm; this strip is called the Helm Bar, as during its appearance the winds are thought to be resisted by it, for on its dispersion they rage vehemently upon the valleys beneath. The direction of the Helm Bar is parallel to that part of the main cloud or collection of vapour that is tinged with white by being struck with the sun's rays; the Bar appears in continual agitation as boiling or struggling with contrary blasts; while the Helm all this time keeps a motionless station. When the Bar is dispersed, the winds that issue from the Helm are sometimes extremely violent; but that force seems to be in proportion to the real current of the winds which blow at a distance from the mountains, and which are frequently in a contrary direction, and then the Helm Wind does not extend above two or three miles; without these impediments it seldom sweeps over a larger track than twelve miles, perhaps from the mere resistance of the lower atmosphere. It is remarkable that at the base of the mountain the blasts are much less violent than in the middle region, and yet the hurricane is sometimes impetuous even there, bearing everything before it, when at a distance of a few miles there is a dead calm and a sunny sky. The spring is most favourable to this phenomenon. The Helm Wind will sometimes blow for a fortnight, till the air in the lower regions, warmed before by the influence of the sun, is thereby rendered piercing cold.

Mr. Ritson thus speaks of the Helm Wind:—"The Helm Wind is generated in that enormous cloud which like a helmet covers the summit of Cross Fell. It is there particularly favoured by circumstances, for on one side there is a plain of about thirty miles in breadth in some places, and on the other no hills to rival that from whence it comes. This wind is not much taken notice of in natural history, yet the Dutch, by the iron chains with which they are obliged to moor their ships at the Cape of Good Hope, bear ample testimony to the fury of such a one. It has been met with by the late voyagers in the South Seas, it is said

to have been felt in the Straits of Gibraltar, and I have no doubt but mariners and travellers have found it in many other places, though they may not have observed it with care, or may have given it other names."

Mr. Richardson remarks, "that in the vicinity of these mountains the air is generally very clear and healthy, owing perhaps to the violent Helm Wind in the months of December, January, February, March, and April; but the inhabitants of the counties immediately influenced by that wind are more subject to rheumatic complaints than those at a greater distance. The summit of Cross Fell and the regions a little lower are sometimes clear, when the vale is covered with a fog; I have been upon the mountain when that has happened, and the spectacle is curious, as the clouds appear firm though uneven like a boisterous disturbed ocean; all distant sounds are at that time heard distinctly, and strike the ear in a very singular manner, as they seem to issue under your feet. As to the Helm, the cloud does not always rest upon the top of the hills, but is sometimes several degrees higher, and does not always preserve a regular form, neither is there always a Helm Bar, for that phenomenon only appears when the wind at a little distance blows from the West. I have sometimes observed four or five of these Helm Bars within five miles of the hills, and then the wind blew irregularly sometimes from the East and sometimes from the West. It appears to me to be the same kind of phenomenon as that at the Cape of Good Hope, described by Sparman. When the snow appears upon the hills the winds then blow with great violence. Swinburne, I think, mentions something similar in Sicily, and Volney at Alexandria. May it not be accounted for by the air being considerably colder on the summit of these hills than in the country whither it rushes with so much violence? I have found by a thermometer that it is 14° colder on the top of Cross Fell than at the bottom—indeed I did but prove that once, but three or four times I found it 12°, and frequently 10°. The name of Helm seems to be derived from the Saxon, and implies covering. Its appearances, according to my remarks, have been that of a white cloud resting upon the summits of the hills, extending even from Brough to Brampton; it wears a bold broad front, not unlike a vast float of ice standing on edge; on its first appearance there issues from it a prodigious noise, which in grandeur and awfulness exceeds the roaring of the ocean. Sometimes there is a Helm Bar, which consists of a white cloud ranged opposite to the Helm, and holds a station various in its distances, sometimes not more than half a mile from the mountain, at others three or four miles; sometimes it is in breadth a quarter of a mile, at others a mile at least: this cloud prevents the wind blowing further westward. The sky is generally visible between the Helm and the Bar, and frequently loose bodies of vapours or small specks of clouds are separated from the Helm and the Bar, and flying across in contrary directions both East and West are seen to sweep along the sky with amazing velocity. When you arrive at the other side of the Bar cloud the wind blows Eastward, but underneath is a dead calm or gusts of wind from all quarters. The violence of the wind is generally greatest when the Helm is highest above the mountains. The cold air rushes down the hill with amazing strength, so as to make it very difficult for a person to walk against it. I have frequently been under the necessity of turning my back to take breath at every ten yards at least. It mostly comes in gusts, though it sometimes blows with unabated fury for twenty-four hours, and continues blowing at intervals of three, four, five, and even six weeks. I have at different times walked into the cloud, and found the wind increase in violence till I reached the mist floating on the side of the hill; when once entered into the mist I experienced a dead calm. If the Helm is stationed above the mountain and does not rest upon it, it blows with considerable violence immediately under the Helm. I once walked so far on the Alston Moor side, till the wind blew from the mountain; hence I supposed that the wind rushes down on each side, and shepherds have frequently told me they have observed it to be so."

To these interesting notices of so very remarkable a phenomenon, it may be added that the appearance of the Helm Bar may be considered as chiefly appearing only to those on the western side of the mountain. At such times Cross Fell, as seen from Alston Moor, does not present any of the remarkable features so fully described in the preceding accounts, with the exception of what is a very common characteristic, a covering of dark and heavy mists. It has been thought by some that the violent gusts of the helm wind

flow in separate streams, as it were, through the atmosphere. In riding on horseback or in a gig along the western base of the Pennine Chain, the air has been found almost perfectly calm eight or ten feet from the ground, while at the same time the tops of the neighbouring trees have been violently bent to and fro with the force of a very powerful wind.

Chas. Slee, Esq., in a paper on this subject, read before the Royal Physical Society, in January 1839, observes: "I have no theory to offer by way of explaining the Helm, inasmuch as some of the facts relating to it appear to me hardly compatible with the laws of matter and motion. Such, for instance, as the perfect repose of the Bar when the current is strongest. Such also is the very circumscribed limits within which it exerts its action. It does not appear to have any dependence on the presence of the sun, for it happens during the night as well as during the day. The circumstance of the Helm only occurring when the wind is Easterly, has led me sometimes to conjecture that an accumulation of air takes place on the eastern side of the mountain, which after a time overcomes the weight of the superincumbent atmosphere and forces itself over the summit and down the opposite side."

These and other circumstances attending it, require further investigation before much can be said with correctness as to the cause of so remarkable a phenomenon.

On the Cause of Helm Wind. By Thomas Barnes, M.D., F.R.S.E., of Carlisle.

From *The History and Topography of the Counties of Cumberland and Westmoreland.* By W. Whellan. Pontefract, Whellan & Co., 1860. 4to. pp. 578-580.

The air or wind from the East ascends the gradual slope of the eastern side of the Pennine Chain or Cross Fell range of mountains to the summit of Cross Fell, where it enters the Helm or Cap, and is cooled to a low temperature; it then rushes forcibly down the abrupt declivity of the Western slope of the mountain into the valley beneath, in consequence of the valley being of a warmer temperature, and this constitutes the Helm wind. The sudden and violent rushing of the wind down the ravines and crevices of the mountains occasions the loud noise that is heard. At a varying distance from the base of the mountain the Helm wind is rarefied by the warmth of the low ground, and meets with the wind from the West, which resists its further course. The higher temperature it has acquired in the valley, and the meeting of the contrary current, occasion it to rebound and ascend into the upper region of the atmosphere. When the air or wind has reached the height of the Helm, it is again cooled to the low temperature of this cold region, and is consequently unable to support the same quantity of vapour it had in the valley; the water or moisture contained in the air is therefore condensed by the cold, and forms the cloud called the Helm Bar. The meeting of the opposing currents beneath—while there are frequently strong gusts of wind from all quarters, and the sudden condensation of the air and moisture in the Bar cloud—give rise to its agitation or connection, as if struggling with contrary blasts. The Bar is therefore not the cause of the limit of the Helm wind, as is generally believed, but is the consequence of it. It is absurd to suppose that the Bar, which is a light cloud, can impede or resist the Helm wind; but if it even possesses a sufficient resisting power it could have no influence on the wind which is blowing near the surface of the earth, and which might pass under the Bar. The variable distance of the Bar from the Helm is owing to the changing situation of the opposing and conflicting currents, and the difference of temperature of different parts of the low ground near the base of the mountains. When there is a break or opening in the Bar the wind is said to rush through with great violence, and to extend over the country. Here again the effect is mistaken for the cause. In this case, the Helm wind, which blows always from the East, has, in some place underneath the observed opening, overcome the resistance of the air, or of the wind from the West, and of course does not rebound and ascend into the higher regions to form the Bar. The supply being cut off, a break or opening in that part of the Bar necessarily takes place. When the temperature of the lower region has

fallen, and become nearly uniform with that of the mountain range, the Helm wind ceases; the Bar and the Helm approach and join each other, and rain not infrequently follows. When the Helm wind has overcome all the resistance of the lower atmosphere, or of the opposing current from the West, and the temperature of the valley and the mountain is more nearly equalised, there is no rebound or ascent of the wind, consequently the Bar ceases to be formed, the one already existing is dissipated, and a general East wind prevails. There is little wind in the Helm cloud, because the air is colder in it than in the valley, and the moisture which the air contains is more condensed, and is deposited in the cloud upon the summit of the mountain. There is rarely either a Helm, Helm wind, or Bar, during the summer, on account of the higher temperature of the summit of the Cross Fell range and the upper regions of the atmosphere at that season of the year. The different situations of the Helm, on the side, on the summit, and above the mountain, will depend on the temperature of these places. When the summit of the mountain is not cold enough to condense the vapour, the Helm is situated higher in a colder region, and will descend the side of the mountains if the temperature be sufficiently low to produce that effect. The sky is clear between the Helm and Bar, because the air below is warmer, and can support a greater quantity of vapour rising from the surface of the earth, and this vapour is driven forward by the Helm wind, and ascends in the rebound to the Bar. In short, the Helm is merely a cloud or cap upon the mountain; the cold air descends from the Helm to the valley, and constitutes the Helm wind; and when warmed and rarefied in the valley, ascends and forms the Bar. An objection has been taken to this theory, on the ground that there is no Helm wind in the valley of the Tyne; but the circumstances are very different, this valley is situated much higher than that of the Eden, and the summit of the mountain on the East is considerably lower than the top of Cross Fell. The former valley has also a high ridge of mountains on the West, the latter a low and extensive plain. The fact that the Helm wind never extends further than the Bar tends to prove the truth of the theory."

"Climate of the Delta of Egypt in 1798-1802, during the French and British Campaigns." By W. G. Black, F.R.Met.Soc., Surgeon-Major. (p. 253.)

CONFERENCES ON "METEOROLOGY IN RELATION TO HEALTH," HELD AT THE INTERNATIONAL HEALTH EXHIBITION.

CONFERENCE ON THURSDAY, JULY 17, 1884.

J. Norman Lockyer, Esq., F.R.S., in the Chair.

The Chairman said, when it was first announced that the subject of Meteorology would form part of the International Health Exhibition, remarks were made that it was not easy to see why such a scientific subject should be brought to the front in connection with such an Exhibition; but without going into details concerning them, it might be pointed out that there were one or two general principles outside the region of Meteorology altogether, which taught in the clearest manner that really both meteorologists and physicians ought to magnify their office, and to say that there could be no health without meteorology, and no care of the human body without it; and, therefore, that practically they were after all playing the part of the Prince of Denmark in the play of 'Hamlet.' The general principles to which he referred were shortly these. On examining the various masses of matter external to our own planet in the Universe, the greatest diversity would be found amongst those bodies which could be approached most easily, such as the stars, those diversities consisting chiefly of difference of temperature and of composition. There were more than

twenty-two millions of stars within our ken, and probably each of those twenty-two millions was in some way unlike any other. The globe on which we dwelt, however, was not a star, that is to say, it was not in a state of incandescence, having cooled down, but the central body, around which it revolved year by year, was a star. Reasoning by analogy, it might be supposed that a great number of those twenty-two millions of stars had planets revolving round them in the same way as the earth revolved around its central luminary; and again, reasoning by analogy, it might be said, almost for certain, that those planets revolving round those stars must vary as much amongst themselves as did the central bodies, and that those planets were cooling bodies like the earth. Approaching the subject of cosmical meteorology, a study of the planetary system had shown the great probability in some cases, and the great improbability in others, of the existence of life on those planets, so that the meteorological condition of each of those masses of matter external to the earth dominated the possibility of life, and *à fortiori*, they must dominate the possibility of health. In fact, if health were a matter of any importance at all, meteorology must lie at the base of all true knowledge of any thing relating to health, so far as the condition of existence on a mass of cooling matter revolving round an incandescent one was concerned. That was a broad general statement, which must be considered to be absolutely true, although it was very much out of the common run of thought. It was not for him to point out, with regret, that these very broad views of the functions of meteorology had not as yet received the attention they demanded, but he did not know that a question of this breadth could be better put before those who were competent to deal with it, so as to lead further along the lines which it suggested, than at such an Exhibition as the present one. Having had the honour of being made Chairman of the Jury which had to deal with meteorological instruments, he had had the pleasure of meeting various foreign jurors who were at work in allied fields, and nothing had struck him more than the very fruitful way in which the intercourse thus brought about promised to do good all round, more especially in enforcing those general views which were connected with such questions as he had suggested. In fact, in that Exhibition itself, there were a number of exhibits from foreign countries of extreme importance on matters dealing with these important questions.

"On some Relations of Meteorological Phenomena to Health." By John W. Tripe, M.D., M.R.C.P. Ed., F.R.Met.Soc., Medical Officer of Health for Hackney.

In ages long past these relations excited much attention, but the knowledge concerning them was of the vaguest kind; and indeed, even now, no very great advance has been made, because it is only quite recently that we have been able to compare a fairly accurate record of deaths with observations taken at a number of reliable meteorological stations. The more useful and searching comparison between cases of sickness, instead of deaths, and meteorological phenomena has yet to be accomplished on a large scale in this country, and especially as regards zymotic diseases. In Belgium there is a Society of Medical Practitioners, embracing nearly the whole country, which publishes a monthly record of cases of sickness, of deaths, and of meteorological observations; but the only attempt on a large scale in this country, which was started by the Society of Medical Officers of Health for the whole of London, failed, partly from want of funds, and partly from irregularity in the returns.

My remarks, which must necessarily be very brief, will refer to the relations between (1) meteorological phenomena and the bodily functions of man, and (2) between varying meteorological conditions and death-rates from certain diseases.

As regards the first, I will commence with a few brief remarks on the effects of varying barometric pressures. A great deal too much attention is paid to the barometer if we regard it as indicating only, as it really does, variations in the weight of the column of air pressing upon our bodies, because, except at considerable elevations, where the barometer is always much lower than at sea-level, these variations produce but little effect on health. At considerable elevations the diminished pressure frequently causes a great feeling of malaise, giddiness,

loss of strength, palpitation, and even nausea; and at greater heights, as was noticed by Mr. Glaisher in a very lofty balloon ascent, loss of sight, feeling, and consciousness. These are caused by want of a sufficient supply of oxygen to remove effete matters from the system, and to carry on the organic functions necessary for the maintenance of life. On elevated mountain plateaux, and health-stations on the Alps, an increased rapidity in the number of respirations and of the pulse, as well as increased evaporation from the lungs and skin, occur.

For some years past, a considerable number of persons suffering from consumption, gout, rheumatism, and anæmic affections have gone to mountain stations, chiefly in Switzerland, for relief, and many have derived much benefit from the change. It must not, however, be supposed that diminished atmospheric pressure was the chief cause of the improvement in health, as its concomitants, viz. a diminution in the quantity of oxygen and moisture contained in each cubic foot of air, and probably the low temperature, with a total change in the daily habits of life, have contributed to the beneficial results. The diminution in the quantity of air, and consequently of oxygen, taken in at each breath is to a certain extent counterbalanced by an increased frequency and depth of the respirations, and a greater capacity of the chest. In this country, alterations in the barometric pressure are chiefly valuable as indicating an approaching change in the wind, and as well as of the amount of moisture in the air; hence the instrument is often called "the weather-glass." A sudden diminution in the atmospheric pressure is likely to be attended with an escape of ground air from the soil, and therefore to cause injury to health, especially amongst the occupants of basement rooms, unless the whole of the ground on which the building stands be covered with concrete.

Temperature.—Experience has shown that man can bear greater variations of temperature than any other animal, as in the Arctic regions a temperature of *minus* 70° Fahrenheit, or more than 100° below freezing-point, can be safely borne; that he can not only live but work, and remain in good health in these regions, provided that he be supplied with suitable clothing and plenty of proper food. On the other hand, man has existed and taken exercise in the interior of Australia, when the thermometer showed a temperature of 120°, or nearly 90° above freezing-point, so that he can live and be in fairly good health within a range of nearly 200° Fahrenheit.

The effects of a high temperature vary very much according to the amount of moisture in the air, as when the air is nearly saturated in hot climates, or even in summer in our own, more or less languor and malaise are felt, with great indisposition to bodily labour. With a dry air these are not so noticeable. The cause is evident; in the former case but little evaporation occurs from the skin, and the normal amount of moisture is not given off from the lungs, so that the body is not cooled down to such an extent as by dry air. Sunstroke is probably the result, not only of the direct action of the sun's rays, but partly from diminished cooling of the blood by want of evaporation from the lungs and skin.

The effects of temperature on man do not depend so much on the mean for the day, month, or year, as on the extremes; for when the days are hot and the nights comparatively cool, the energy of the system becomes partially restored, so that a residence near the sea, or in the vicinity of high mountains, in hot climates is, other things being equal, less enervating than in the plains, for the night air is generally cooler. It is commonly believed that hot climates are *necessarily* injurious to Europeans, by causing frequent liver derangements and diseases, dysentery, cholera, and fevers. This, however, is, to a certain extent, a mistake, as the recent medical statistical returns of our army in India show that in the new barracks, with more careful supervision as regards diet and clothing, the sickness and death-rates are much reduced. Planters and others, who ride about a good deal, as a rule keep in fairly good health; but the children of Europeans certainly degenerate, and after two or three generations die out, unless they intermarry with natives, or make frequent visits to colder climates. This fact shows that hot climates, probably by interfering with the due performance of the various processes concerned in the formation and destruction of the bodily tissues, eventually sap the foundations of life amongst Europeans; but how far this result has been caused by bad habits as regards food, exercise, and self-indulgence, I cannot say. Rapid changes of temperature in this country are often very injurious to the young and old, causing diarrhœa and derangements

of the liver when great heat occurs, and inflammatory diseases of the lungs colds, &c. when the air becomes suddenly colder, even in summer.

The *direct* influence of *rain* on man is not very marked in this country, except by giving moisture to the air by evaporation from the ground and from vegetable life, and by altering the level of ground water. This is a subject almost overlooked by the public, and it is therefore as well that it should be known that when ground water has a level, persistently less than five feet from the surface of the soil, the locality is usually unhealthy, and should not, if possible, be selected for a residence. Fluctuations in the level of ground water, especially if great and sudden, generally cause ill-health amongst the residents. Thus, Dr. Buchanan in his Reports to the Privy Council in 1866-67, showed that consumption (using the word in its most extended sense) is more prevalent in damp than on dry soils, and numerous reports of medical officers of health, and others, which have been published since then, show that an effective drainage of the land, and consequent carrying away of the ground water, has been followed by a diminution of these diseases.

Varying amounts of moisture in the air materially affect the health and comfort of man. In this country, however, it is not only the absolute but the relative proportions of aerial moisture which materially influence mankind. The quantity of aqueous vapour that a cubic foot of air can hold in suspension, when it is saturated, varies very much with the temperature. Thus at 40° it will hold 2·8 grains of water; at 50°, 4·10 grains; at 60°, 5·77 grains; at 70°, 8·01 grains; and at 90° as much as 14·85 grains. If saturation be represented by 100, more rapid evaporation from the skin will take place at 70° with 75 per cent of saturation than at 60° with complete saturation, although the absolute quantity of moisture in the air is greater at the first-named temperature than at the latter. As regards the lungs, however, the case is different, as the air breathed out is, if the respirations be regular and fairly deep, completely saturated with moisture at the temperature of the body. In cold climates the amount of moisture and of the effete matters given off from the lungs in the expired air, is much greater than in hot climates, and the body is also cooled by the evaporation of water in the form of aqueous vapour. Moist air is a better conductor of heat than dry air, which accounts for much of the discomfort felt in winter when a thaw takes place, as compared with the feeling of elasticity when the air is dry. In cold weather therefore, moist air cools down the skin and lungs more rapidly than dry air, and colds consequently result. London fogs are injurious, not only on account of the various vapours given off by the combustion of coal, but in consequence of the air in winter being generally saturated with moisture at a low temperature. The injuriousness of fogs and low temperatures will be presently dwelt upon at greater length.

Variations in the pressure and temperature of the atmosphere exert a considerable influence on the circulation of air contained in the soil, and which is called ground air. As all the interstices of the ground are filled with air or water, the more porous the soil, the greater is the bulk of air. The quantity of air contained in soil varies very much according to the material of which the soil is composed, as it is evident that in a gravelly or sandy soil it must be greater than when the ground consists of loam or clay. The estimates vary from 3 to 30 per cent., but the latter is probably too high. If, therefore, a cesspool leak into the ground the offensive effluvia, if in large quantities, will escape into the soil, and be given off at the surface of the ground, or be drawn into a house by the fire; but, if small, they are rendered innocuous by oxidation. The distance to which injurious gases, and suspended or dissolved organic matters, may travel through a porous soil is sometimes considerable, as I have known them pass a distance of 130 feet along a disused drain, and above 30 feet through loose soil.

Winds exercise a great effect on health both directly and indirectly. Directly by promoting evaporation from the skin, and abstracting heat from the body in proportion to their dryness and rapidity of motion. Their indirect action is more important, as the temperature and pressure of the air depend to a great extent on their direction. Thus, winds from the North in this country are usually concomitant with a high barometer and dry weather; in summer with a pleasant feeling, but in winter with much cold. South-west winds are the most frequent here of any, as about 24 per cent. of the winds come from this quarter against 16½ from the West, 11½ from the East, and the same from the

North-east; 10½ from the South, 8 from the North, and a smaller number from the other quarters. South-west winds are also those which are most frequently accompanied by rain, as about 30 per cent. of the rainy days are coincident with South-west winds. Another set of observations give precisely the same order, but a considerable difference in their prevalence, viz. South-west 31 per cent, West 14½, and North-east 11½ per cent. Easterly winds are the most unpleasant, as well as the most injurious to man, of all that occur in this country.

I now propose discussing very briefly the known relations between meteorological phenomena and disease. I say the known relations, because it is evident that there are many unknown relations, of which at present we have had the merest glimpse. For instance, small-pox, while of an ordinary type, and producing only a comparatively small proportion of deaths to those attacked, will sometimes suddenly assume an epidemic form, and spread with great rapidity at a time of year and under the meteorological conditions when it usually declines in frequency. There are, however, in this country known relations between the temperature and, I may say, almost all diseases. As far back as 1847, I began a series of elaborate investigations on the mortality from scarlet fever at different periods of the year, and the relations between this disease and the heat, moisture, and electricity of the air. I then showed that a mean monthly temperature below 44°·6 was adverse to the spread of this disease, that the greatest relative decrease took place when the mean temperature was below 40°, and that the greatest number of deaths occurred in the months having a mean temperature of between 45° and 57°. Diseases of the lungs, excluding consumption, are fatal in proportion to the lowness of the temperature and the presence of excess of moisture and fog. Thus in January, 1882, the mean weekly temperature fell from 43°·9 in the second week to 36°·2 in the third, with fog and mist. The number of deaths registered in London during the third week, which may be taken as corresponding with the meteorological conditions of the second week, was 1700, and in the next week 1971. Unusual cold, with frequent fogs and little sunshine, continued for four weeks, the weekly number of deaths rising from 1700 to 1971, 2023, 2632, and 2188. The deaths from acute diseases of the lungs in these weeks were respectively 279, 481, 566, 881, and 689, showing that a large proportion of the excessive mortality was caused by these diseases. At the end of November and in December of the same year there was a rapid fall of temperature, when the number of deaths from acute diseases of the lungs rose from 297 to 358, 350, 387, 541, 553, and 389 in the respective weeks. From November 29 to December 9 the sun was seen on two days only for 4½ hours, and from December 9th to the 18th also on two other days for less than 4 hours, making the total amount of sunshine 8·5 hours only in 20 days. In January and February the excess of weekly mortality from all diseases reached the large number of 504 deaths; in December it was less, the fogs not having been so dense, but the excess equalled 246 deaths per week. In January 1881 there was much greater and long-continued cold, but the mortality was smaller, as there was less fog, and the oscillations of temperature were not so large.

The relations between a high summer temperature and excessive mortality from diarrhœa have long been well known, but the immediate cause of the disease as an epidemic is not known. Summer diarrhœa prevails to a greater extent in certain localities, notably in Leicester (and has done so for years); and the cause has been carefully sought for, but has not been found out. Recent researches, however, point to a kind of bacillus as the immediate cause, as this has been found in the air of water-closets, in the traps under the pans, and the discharges from infants and young children.[1] In order to indicate more readily how intimately the mortality from diarrhœa depends on temperature, I now lay before you a table showing the mean temperature for ten weeks in summer, of seven cold and hot summers, the temperature of Thames water, and the death-rates of infants under one year per million population of London:—

[1] In my Sanitary Report to the Hackney Board of Works for 1879 I pointed out the presence of bacteria in the air of water-closets, and in the contents of traps during hot weather, during the prevalence of summer diarrhœa.

TABLE SHOWING THE NUMBER OF DEATHS IN LONDON UNDER ONE YEAR, IN JULY, AUGUST AND PART OF SEPTEMBER, FROM DIARRHŒA PER 1,000,000 POPULATION LIVING AT ALL AGES, ARRANGED IN THE ORDER OF MORTALITY.

Years.	Mean Temperature, 10 Weeks.	Temperature of Thames Water.	Age 0—1 Year. Deaths from Diarrhœa per 1,000,000 population living at all Ages.
	°	°	
1860	58·1	60·6	151
1862	59·0	62·0	189
1879	58·7	60·7	228
1877	61·2	63·3	347
1874	61·7	63·8	447
1878	63·7	64·1	576
1876	64·4	64·9	642

As may be seen, the deaths of infants under 1 year of age from diarrhœa per 1,000,000 population was only 151 in 1860; whilst the mean summer temperature was only 58°·1, against 189 in 1862, when the mean temperature was 59°·0. In 1879, when the mean temperature was 58°·7, the deaths from diarrhœa rose to 228 per million, but a few days were unusually hot. In 1877 the mean temperature of the air was 61°·2, of the Thames water 63°·3, and the mortality of infants from diarrhœa 347 per million population. In 1874, when the mean temperature of the air was 61°·7, the mortality rose to 447 per million; and in the hot summers of 1878 and 1876, when the mean air temperatures were 63°·7 and 64°·4 respectively, the death-rates of infants were 576 and 642 per million population. The relations, therefore, between a high summer temperature and the mortality from diarrhœa in infants are very intimate. I have selected the mortality amongst infants in preference to that at all ages, as death occurs more quickly, and because young children suffer in greater proportion than other persons from summer diarrhœa.

The proportionate number of deaths at *all ages* from diarrhœa corresponds pretty closely with those of infants. To prove this, I made calculations for three years, and ascertained that only 3·9 per cent. of all the deaths from this disease were registered in the weeks having a temperature of less than 50°; 11·9 per cent. in the weeks having a temperature between 50° and 60°, whilst in the comparatively few weeks in which the temperature exceeded 60°, as many as 84·2 per cent. of the total number of deaths from this disease was registered. In the 17 years 1840-56, for which many years ago I made a special inquiry, only 18·9 per cent. of all the deaths from diarrhœa occurred in winter and spring, against 81·1 per cent. in summer and autumn. In the 20 years, 1860-79, there were seven years in which the summer temperature was in defect, when the mortality per 100,000 inhabitants of London was 200; whilst in 10 summers, during which the temperature was in excess by 2° or less, the mortality was 317 per 100,000. The mean temperature was largely in excess, that is to say, more than *plus* 2° in three of these summers, when the mortality reached 339 per 100,000 inhabitants. These figures show that great care should be taken in hot weather to prevent diarrhœa, especially amongst young children; by frequent washing with soap and water, to ensure cleanliness, and proper action of the skin; by great attention to the food, especially of infants fed from the bottle; free ventilation of living rooms, especially of bedrooms; and by protection, as far as possible, being afforded from a hot sun, as well as by avoiding excessive exercise. All animal and vegetable matter should be removed from the vicinity of dwelling-houses as quickly as possible (indeed these should be burnt instead of being put in the dust bin), the drains should be frequently disinfected and well flushed out, especially when the mean daily temperature of the air is above 60°.

Time will not admit of more than a mere mention of the relations between meteorological phenomena and the mortality from many other diseases and affections, such as apoplexy from heat, sunstroke, liver diseases, yellow fever,

cholera, whooping-cough, measles, and several other affections. A comparison between the mortality from several diseases in this and other countries shows that certain of these affections do not prevail under closely corresponding conditions. Thus the curves of mortality from whooping-cough, typhoid fever, and scarlet fever, do not correspond with the curves of temperature in both London and New York, and the same may be said of diarrhœa in India. It is, therefore, evident that some other cause or causes than a varying temperature must be concerned in the production of an increased death-rate from these diseases. The subject is one of great importance, and I do not despair of our obtaining some day a knowledge of the agents through which meteorological phenomena act in the production of increased and decreased death-rates from certain diseases, and the means by which, to a certain extent, their injurious effects on man may be prevented.

"ENGLISH CLIMATOLOGICAL STATIONS." By G. J. SYMONS, F.R.S., Secretary of the Royal Meteorological Society.

THE Royal Meteorological Society has equipped a Climatological Station in the grounds of the International Health Exhibition, in order that any one desirous of organising a station may see one arranged in accordance with the regulations of the Society. It must be stated at the outset, however, that the enclosure is much too small, but the exigencies of the Exhibition would not permit of more space being granted. The object of the Climatological Station is to determine the elements of the climate of a place, hence only such instruments are used as are necessary for that purpose. These consist of a maximum, a minimum, a dry and a wet bulb thermometer, which are mounted in a Stevenson screen of the Society's pattern, and a rain-gauge.

The screen is a double-louvred box, its internal dimensions being: length 18 inches; width 11 inches, and height 15 inches; with a double roof, the outer one sloping from front to back, *i.e.* from north to south. The front, or northern side of the screen, is hinged as a door, and opens downwards. This screen is placed in an exposed situation over grass, and is mounted on posts at such a height that the bulbs of the thermometers are 4 feet above the ground. The thermometers are suspended on uprights near the middle of the screen, the maximum and minimum being in front of the dry and wet. The maximum thermometer registers the highest, and the minimum the lowest temperature during any interval. The dry bulb shows the temperature of the air at the time. The bulb of the wet thermometer is covered with a piece of fine muslin, which is kept damp by the capillary action of a few threads of cotton fastened round the neck of the bulb, their other ends being immersed in a cup of water. As evaporation takes place from the muslin a reduction of temperature ensues, and hence this thermometer reads lower than the dry bulb. The drier the air, the greater is the difference between the readings of these two thermometers. Therefore, by this very simple method, we have a means of ascertaining the humidity of the air.

From observations of these instruments the highest, lowest and mean temperatures, the range of temperature, as well as the humidity of the air of any locality, can be obtained. Each of these conditions, as is well known, exerts a very great influence on health. This is especially true in the case of range of temperature, as two places having the same mean temperature during a certain period may differ very considerably in range of temperature, one town having a generally equable temperature, while another may be subject to great extremes of heat and cold. It is, therefore, very necessary to ascertain the range of temperature, in choosing a health-resort, or a place of residence, either for invalids or even for persons enjoying good health. The humidity of the air is also of great importance in determining the climate of a place, as dry air agrees with some persons, while moist air is more suitable for others; and the effect of moisture on health being largely regulated by temperature, both must be taken into account.

It was stated at the outset that a rain-gauge formed part of the equipment necessary for a Climatological Station. Now, although rainfall does not appear to exert so direct an influence on health as do temperature and humidity, never-

theless it has indirectly a very great power over the health and well-being of man. Every water supply depends, either directly or indirectly, on the amount of rainfall, and our own existence depends on the amount of water supply, as everything on which we subsist is dependent for its life and growth on the amount of rainfall. Observations of rainfall are also most important to engineers, as in planning a water supply for any town they can, by means of rainfall observations, ascertain where in the neighbourhood most rain falls, and place the reservoirs accordingly. Also, in carrying out the drainage of any place, it is necessary, first of all, that the engineer should know the greatest rainfall he may have to provide for, so that he may make his sewers of such dimensions that they may be able to carry off a large and heavy fall of rain without any inconvenience or flooding, or may be so arranged as to exclude it.

It was, therefore, in the hope that similar stations may be started at as many as possible of the English health and sea-side resorts, that the Royal Meteorological Society erected the equipment necessary for a "Climatological Station." Up to the present time, the Society has succeeded in establishing 82 stations in widely separated localities, from each of which monthly returns of observations are made with accurate and verified instruments are received; and each station is regularly inspected by the Assistant-Secretary. The positions of these stations are shown on the map on the wall,[1] and, from a single glance at their distribution over the country, it is obvious that there is still room for many more. Take the coast from the Thames to the Land's End. We find the following sea-bathing places without any records being sent to the Society respecting their temperature or humidity:—Herne Bay, Westgate, Broadstairs, Deal, Dover, Folkestone, Sandgate, Hythe, St. Leonard's, Eastbourne, Seaford, Brighton, Littlehampton, Bognor, Hayling Isle, Southsea, Cowes, Ryde, Sandown, Shanklin, Freshwater, Bournemouth, Charmouth, Lyme Regis, Axmouth, Seaton, Budleigh Salterton, Exmouth, Dawlish, Brixham, Kingswear, Looe, Fowey and Penzance. Thirty-four places on the South Coast alone, each doubtless possessing features different from every other, slight, probably, in some cases, as, for example, Littlehampton and Bognor; but extremely marked in others, as, for instance, Dover and Penzance, or—to take two places nearer together—Ryde and Shanklin. It is this deficiency of information from so many important places which has induced the Royal Meteorological Society to endeavour to obtain additional help by making the need of records from such localities more widely known.

It is difficult to fix the number of stations requisite, because it depends so largely on the physical configuration of the district, and even of the towns. For instance, an author some time ago wrote a pamphlet on "*Brighton and its Three Climates*," and a moment's consideration will convince any one that the difference, say, between Maze Hill, St. Leonard's, and the Marina, St. Leonard's; or between High Harrogate and Low Harrogate, is greater than would be produced by dozens of miles of distance in other parts of the country.

The first object of the Royal Meteorological Society is to lay a foundation by discussing and publishing accurate observations made with tested instruments, all mounted uniformly, all read at the same instant of local time, and recorded and in every way discussed upon a uniform system.

This, in the Society's *Meteorological Record*, which is published quarterly, it has now done for nine years, and the author trusts that by degrees the medical men of this country will increasingly refer to the publications of the Society for accurate data as to the climates of our various health resorts; because the many demands on the time of a physician necessarily render it impossible for him to obtain personal knowledge of the climate of the dozens of English watering places by a permanent residence in each of them.

Some years since the author urged the collection, by a commission of experts, of a complete statistical record of the health-rate, death-rate, geology, climate, water supply, drainage, and general condition of all our mineral-water, sea-bathing, or pure air resorts; and he adheres to the opinion that the collection of such statistics would have both direct and indirect beneficial effects infinitely beyond the cost of the inquiry. But it must be done by authorities of unquestioned position, men who are not only beyond all bribery, but who would and

[1] See *Meteorological Record*, No. 12.

could give personal care to see that absolute impartiality and absolute justice ruled throughout.

DISCUSSION.

Mr. J. K. LAUGHTON said Dr. Tripe had referred to the effects of low barometer pressure on the human frame as producing *malaise*, sickness, and other disagreeable effects; but he had heard experienced mountaineers say that a great deal of that was simply due to want of training. They knew from the sickness felt in balloon ascents that it was not entirely owing to that cause, though a great deal of it might be. If any one who had been living for ten months in London, not breathing always the freshest of air, going to bed later than he ought, and very probably eating and drinking more than he ought to, suddenly went into a hilly country, and determined to ascend a mountain, it was found that by the time he got a few thousand feet up he did not feel very cheerful. A curious observation had been made by David Forbes in the Andes, where he made some measurements of a tribe who lived and worked at an elevation of nearly 14,000 feet; he found the average chest measurement of a man was something like 46 inches, which struck him at the time as enormous, but probably these people, living generation after generation in that peculiar climate, had gradually developed chests of that extreme size. What had been said about moisture as affecting climate struck him very much, and was probably familiar to all who had been in hot countries. He might say that the hottest day he ever felt was when the thermometer was only 85°, though he had experienced temperatures a great deal higher than that, but probably at the time to which he referred the air was saturated with moisture.

Mr. R. H. SCOTT remarked, in reference to mountain sickness, that Mr. Whymper had given him a very accurate description of his own sensations in that way. He took up two Swiss guides with him in some of his ascents, and when they got up to 14,000 or 15,000 feet, they all three of them felt this mountain sickness. They had certainly not come recently from London dinners. Mr. Whymper cured himself by using chlorate of potash; but the party had with them a gentleman who had spent some years at Quito, who had not lived a remarkably regular life, and who was apparently very delicate, but he was perfectly free from this mountain sickness, having lived at a high level for several years. Mr. Whymper found it took about four or five days to overcome these symptoms entirely, and after his getting over them they did not return. With reference to the feeling of sickness in balloon ascents, he was rather disposed to consider that it was not usually connected with the ascent, but it was more related to a form of sickness, from which few people were free, due to the motion. Those who went up in the captive balloon at Paris found themselves swaying about as if on a rough sea, and he had heard of officers, who, in the experiments carried on at Chatham with a captive balloon, found it so unpleasant that they cut themselves loose, and when the balloon was free they found no perceptible motion at all; he fancied, therefore, it was something in the nature of sea-sickness.

Dr. R. J. MANN said he believed that the effect of the low barometer in producing the effects it did on the animal frame was almost always connected with the effect of muscular action. This undoubtedly was the case in making mountain ascents, and he had no doubt that in nine cases out of ten where you had a low barometer, the nervous discomfort was due to the fact that the individual suffering from it endeavoured to make the same energetic muscular action that he would under ordinary circumstances. If you noticed the guides in any mountain district, they generally moved at about one-fourth the pace of the party they accompanied. The highest climb he had ever done did not exceed 8,000 feet; but having carefully observed the effects on his own experience, he found that by diminishing his muscular efforts to that of his guide, he was instantly free from all nervous pressure. Persons making a new kind of action, and bringing a new series of muscles into play day after day for a little time, soon found a compensation provided which got over those unpleasant effects. Mr. Scott would probably say that persons did not make muscular efforts in a balloon, but he had himself explained that the swaying motion there was closely analogous to sea-sickness. The recent investigations which had been made were very important, as showing that the capacity of the chest increased with those who lived at high

altitudes. Amongst some of the best observations on this point were those made within the last two or three years by Dr. Theodore Williams, who had a large connection with Davos Platz, and, when making one or two visits there recently, he made some most exact and careful measurements of the chest capacities of the persons living in those climates. He found there was a much larger capacity of chest amongst them than amongst persons living at lower altitudes, all other circumstances being similar. The only other point he wished to refer to was to record very strongly his opinion of the value of the investigations which were entered upon in recent years by such societies as the Royal Meteorological, and also the extreme value of such modes of illustrating that science as were now to be seen in the Exhibition. Going into the small Annexe allotted to the Society a series of charts would be found, which were full of the most valuable information. When the room was first opened he went in and looked at them, knowing something of these things, and having thought about them for many years, but there were some charts there of which he did not quite understand the meaning. He went to two or three persons, and asked them to tell him, but one very frankly answered that he did not know, and altogether he did not get much light upon the matter; but having studied them a little longer himself, in order to complete his own knowledge, he wrote to a friend who did know, and got some inkling of what was meant; then, for the first time, he apprehended their true value. He mentioned this to point out that charts of this kind were of little value until their whole meaning was mastered by the popular mind; but then it would cling to them through life, and show the value of this science as connected with human health. He would not go further into the subject now, because it would be dealt with on the following day by Mr. Scott. In the absence of Dr. Compton, of Bournemouth, he would say that there was one particular work now being done at Southbourne, which was about half-way between Christchurch and Bournemouth, which was of great importance. For two or three years Dr. Compton had been carefully and closely watching the records of sunshine, and it appeared that that locality stood second, Hastings being first of all, on the south coast, where observations had been made with regard to sunshine. He hoped before long they would have many more valuable records on that point.

Mr. F. W. CORY said he had listened with great pleasure to Dr. Tripe's highly interesting and instructive Paper, and should like to supplement his experience with a remarkable fact discovered in regard to the effect of certain states of the atmosphere on the symptoms of whooping-cough, and which fact was a stepping-stone to a great improvement in the treatment of that disease. During March and April, 1882, a rather severe epidemic of whooping-cough occurred at Chingford, a small village about ten miles to the north of London; whilst watching the course of the cases, he noticed on several occasions a decided remission in the symptoms, and then at other times a marked aggravation. This induced him to suspect some powerful atmospheric influences at work, and on consulting his charts he found that the increase in the number and violence of the whoops corresponded to an absence or a very low percentage of ozone or other purifiers in the air, whilst, on the other hand, a decrease was accompanied by an extremely deep tinting of the ozone papers. This seemed to suggest a new line of treatment, and forthwith all his little patients suffering from this disease were treated with an antiseptic medium internally, and the result, he was pleased to say, was very satisfactory; and, moreover, further experience confirmed the plan adopted. He had not yet published in any of the medical journals this new therapeusis of whooping-cough. He would have done it before, but so many specifics had been recommended and found wanting, that he was loth to prematurely risk the possible addition of another to the list of multitudinous drugs of a questionable nature used in this complaint. The present time, however, seemed to be a happy one for making it public. It was just as well to refer to the fact that the pocket spectroscope would prove a rough and ready but reliable ozonometer to those who did not suffer from colour-blindness, and who possessed the requisite acuteness of vision.

Mr. C. G. TALMAGE, referring to the observations which had lately been made as to the duration of sunshine at various spots, suggested that it was a misnomer, to term the instrument used a sunshine recorder; it was not anything of the kind, it was a clear sky recorder, and the reason he said so was this: He had used one for nearly eight months, and he found that during the presence of the very

thinnest and faintest cirrus cloud there was no trace whatever of recorded sunshine. When speaking amongst themselves, they would say that they had had a glorious sunshiny day, though on the register they might find no trace of it at all. Then perhaps they might get a very heavy thunderstorm, lasting half-an-hour, which would saturate the paper, and, though it was clear afterwards, until that paper was dried there was another half or three-quarters of an hour at least before the clear sky was again recorded. He was not at all disparaging the sunshine recorder as an instrument, but he would recommend persons not to pin their faith in seeking a health resort on the amount of sunshine as shown by the recorder. If it were called a clear sky recorder, he should be quite satisfied.

Mr. E. Mawley said he had used the sunshine recorder, and he found it recorded all sunshine likely to have the slightest effect as regarded health or vegetation. It did not take three-quarters of an hour to burn through a saturated card, but more nearly three-quarters of a minute. He wished, however, to speak with regard to the temperature, which perhaps had more influence on health than any other element observed at a meteorological station. In fact, the first observation made with respect to any climate was generally as to the temperature. It became, therefore, of great importance to have a correct mode of gauging the temperature in different localities, and comparing them one with another. At first sight it might appear a very unnatural proceeding to place thermometers in one of those screens, but on a careful consideration of the subject it would be seen that no better method could be adopted. The double louvres shut out entirely the direct rays of the sun, and direct radiation from below, which on cold clear nights prevented the minimum thermometer cooling down unduly. In fact, the thermometers were influenced by hardly any thing but the currents of air passing over them. But with regard to the advantages of this screen, some meteorologists had regarded the temperature taken in them with more or less suspicion. Some said that the roof became heated by the sun's rays, so that the heat was conveyed ultimately to the thermometer; others, that the louvres being exposed to the full rays of the sun for many hours became too hot, and that the air passing through them into the screen must be heated; whilst others held that they were so poorly ventilated that they doubted whether the air ever did get into them or how it could get out. Now he hoped to show that these screens were far more trustworthy than had been supposed. For the purpose of experiment he had placed two of these screens on his own lawn, precisely alike in all respects, except that whilst one was unprotected the other was shaded on the top and on the south and west sides by means of canvas. They were only a few yards apart, and the thermometers placed in them, kindly lent by Messrs. Negretti and Zambra, were precisely alike. He found that among the maximum observations for the nine hottest days of the year the shaded screen was less than 0°·2 below the unshaded one. In order further to test it at three o'clock he took observations with the dry bulb, and taking the seven hottest days of the year—no observations being taken under 75°—he found that the mean dry bulb reading of the shaded screen was 78°·6, whilst that of the unshaded screen was 78°·3, and with the sling thermometer 78°·5. The rather low temperature in the unshaded screen he attributed to the shadow of a chimney coming within two yards of the screen and cooling the ground, and consequently, to a slight extent, the air in the screen. The result appeared to him to be, that instead of shading these screens, they ought to be placed in the most open and exposed positions possible. These comparisons were to his mind eminently satisfactory and encouraging, as showing that the main cause for dissatisfaction with this screen, based on the supposition that in very hot weather it got heated up, had no foundation in fact.

Mr. R. Strachan said he regarded the sunshine recorder as the most practical meteorological instrument invented since the Brussels Conference in 1853, and with the form introduced by Professor Stokes, not only had you an accurate and reliable instrument, but a cheap one, and with proper care there was no reason for its failure whatever. He should rather imagine that it would give an excessive record, excepting at the hours of rising and setting, because with a glass globe properly focussed the heat developed was so intense that the registration must be almost instantaneous. There was no doubt that the heat developed would amount to 2,000°, and whether the card were damp or not, it could not stand such a heat as that. The study of the distribution of sunshine was very in-

teresting, and, so far as his own investigation had gone, it had impressed him with surprise as to the anomalous distribution; the east of England seemed to have the most, next the south-west, and next the south of Ireland; therefore it was quite clear that if those instruments were properly worked records might be obtained which would be of very great importance. An objection had been taken to the stations, that some of them were too much crowded together, and it had been said before now that meteorology was heaping up millions of figures most of which were and would be useless. Considering that some of the stations were so close together as Southbourne and Bournemouth, and even Westbourne within a mile or two of each other, the conclusion could not be avoided that a large amount of superfluous work was being done, but at the same time there was a meteorological difference between those two stations. Some doctors stated that Bournemouth was relaxing, and that might be true with regard to one part of Bournemouth, but it could not be true of the Westbourne district. These little distinctions when understood would determine the localities where physicians should send their patients, and the difference of a mile or two would determine whether a place were bracing or relaxing, there being very often a great difference within a short distance. Then came the question of the distribution of rain, and the differences on the English coast were very surprising, and along the coast of Cornwall and Devonshire there was a very heavy rainfall, but when you got up to Bournemouth you found the rainfall dropped from 50 inches to below 30. These discrepancies came out as the result of an enormous number of observations, and if that amount of work done could be classified so as to bring out the salient points and save the multiplication of figures, he thought the results would be more generally useful.

Mr. C. Harding said he had listened to both these papers with great interest. He did not quite agree with Mr. Strachan that they had too many figures. Undoubtedly they had stored up a great quantity, but what was wanted was an army of doctors, like Dr. Mann, to discuss these figures which had been collected. He was much struck by the remark of Dr. Mann, that the public generally, and even those people specially interested, would not inquire sufficiently into the meaning of diagrams placed before them; they looked at them and if they did not see the meaning immediately they passed on, whereas if they would only give five or ten minutes' careful study, they would find there was nothing beyond their grasp, but for want of that they went on in blissful ignorance for the whole of their lives on the most simple points. The map of climatological stations might strike one as giving a great number somewhat close together, but he agreed with Mr. Symons with regard to the south coast, that the stations were by far too few. Mr. Strachan had alluded to places, such as Bournemouth, where there were two close together, but he could readily believe that at such a place as Hastings, and many others with hills in the vicinity, a great difference might exist between the climate of one spot and another only a mile distant, because the hills would materially affect the temperature. To give one instance of radiation at night. The cooling down of the earth would cool the layer of air in contact with it, and if there were not much wind blowing that layer would roll down the hill-side. Many people supposed that you had a colder air at the top of the hills, which was a great mistake; you had a really colder air at the lower part of the hill, due to this nocturnal radiation. There were many other instances which would readily suggest themselves, showing how the lie of the land might influence the temperature and the winds. Memory was proverbially treacherous, and he would not attempt to go over the ground which Dr. Tripe had traversed, with regard to the influence of temperature on health, but he should like to refer to last year, when there was a mild winter and a cool summer—an absence of extreme temperature, which was favourable to health. In the winter the deaths from respiratory disease were far below the average; March was extremely cold, about 6° below the average, and it would be found that in April and May the deaths from disease of the respiratory organs were excessively numerous, but that was only just after that extremely low temperature. Again, in the summer, there was a cool temperature, and therefore a low death-rate from scarlet-fever and other zymotic diseases. Another point, which was extremely interesting, was the almost entire absence of small-pox at the early part of the year. Small-pox gave its maximum about May or June, and decreased in a marked manner when the temperature in-

creased, so that you may calculate on its being nearly stamped out in the hot summer weather. But this year the conditions were altogether different. There was almost an epidemic of small-pox, the deaths being over the average, though apparently with somewhat different conditions of weather to last year, though perhaps if the subject were inquired into more minutely, it would be found there were conditions present now which did not exist then. Last year on the whole the deaths in London were about 7 per cent. below the average; from zymotic diseases they were about 23 per cent. below the average; and from diseases of the respiratory organs 11 per cent. Fog, of course, was an important factor in diseases of the respiratory organs, and we have been very free from that lately. On the other hand, it must be remembered that though a cold winter increased the death-rate in some respects, if you had cold weather you usually had a quiet winter, and if you had a warm winter it was usually stormy; so that though it might be favourable on land it promoted deaths from shipwreck. With regard to the sense of nausea in balloon ascents, no doubt Mr. Scott was right when he attributed that feeling to the swaying motion of a captive balloon, but he did not think that was the whole cause of it. There were cases of nausea when there was a free ascent to very great heights. He had not experienced it himself, as he had not been higher than three miles, but he believed it was greatly attributable to the escape of gas, which always went on when the balloon was rising rapidly, and that might very possibly give rise to this feeling of nausea.

Mr. T. Wilson said the effect of rarefied air was very beneficial in cases of brain fatigue. He had found that staying at Braemar, or in the Alps, had a very good effect. Now, there were at Malvern, and other places, chambers for compressed air, which were very useful in some diseases, and he would suggest whether they could not have exhausted air chambers to relieve brain discomfort without having to go to the Alps.

Mr. F. J. Sparks observed that a complete record of sunshine observations would be of very great value, especially to those engaged in farming operations. In his opinion, however, a cold winter and a hot summer were best, both for the crops and animals.

Prof. Matthew Hay wished to refer especially to one point mentioned by Dr. Tripe, namely, the influence of ground water on health. This matter had not received much attention yet in this country, but in Bavaria it had been worked out under the able superintendence of Professor Pettenkofer, one of the foremost leaders in hygienic science in Europe. He had made innumerable and constant observations from day to day on the height of the ground water of Munich, and found that when the ground water fell mortality rose, especially that due to typhoid fever; he thought, therefore, it was highly necessary that similar observations should be made in England. He had recently the opportunity of speaking to Professor Pettenkofer on the matter, and found he attached so much importance to the height of ground water as an indication of the climatology of Munich, that although for the past month it was excessively low, and, therefore, typhoid might be expected, yet very recently it had been rising rapidly, and from that he felt certain that the typhoid mortality would sink, and not only that, but if it continued to rise there was hardly any chance of cholera taking place in Munich. He said that he observed three important epidemics of cholera in Munich, and when the ground water rose the cholera disappeared, or if the epidemic chanced to be in Europe at the time when the ground water of Munich was high it never reached there or took root. The ground water probably was merely an indication of the rainfall; a correct measure of the amount of water which fell and penetrated through the soil, and in so doing acted upon it in a particular manner. It was the only correct measure we had of the amount of rain which actually passed through the soil; that which evaporated was practically of little or no consequence in connection with health.

Mr. Baldwin Latham said he had been tabulating for a number of years observations of ground water in this country at a great number of stations, and he could predict with absolute certainty, in the districts those stations belonged to, the occurrence of an epidemic of typhoid fever ten days or a fortnight before it broke out. It was not a question as to whether it could be done, for it had been done, and he could refer to sanitary authorities to whom he had communicated the information he had received, and who on that information had issued placards

cautioning the people as to the steps to be taken. There could not be the slightest doubt about this question of underground water having a direct bearing on public health, and it would be found on studying the statistics of all zymotic diseases, excepting diarrhœa, that almost all of them followed percolation. Diseases were rife during the time of percolation, but as the water passed through the ground they declined. It was not the lowness of the water which caused typhoid fever, but the lowness of the water was the measure of the intensity with which the disease would follow that period of lowness. It was clear from the observations made by a celebrated German biologist that it was absolutely essential before typhoid fever could break out that a certain degree of development of the poison should occur in the ground, and after that development had taken place the first rains which passed through the subsoil water would give typhoid. That was because the water passing into the ground drove the ground air out. This question, therefore, was intimately connected with the construction of a house; and it was most essential from a sanitary point of view that some means should be taken to cut off, especially in districts where the whole soil had been fouled for generations, all communication between the soil and the house. If that were done, one of the great sources of typhoid and other diseases would disappear. Diarrhœa was entirely to his mind a question of the temperature of the drinking water. He had been for years in various places carrying on observations on this question, and it was not until the temperature of drinking water rose over 60° that diarrhœa became prevalent. The temperature was above that point now in London, and diarrhœa was becoming prevalent. In some country districts which drew their water supplies even from the most impure sources, if the water remained cold throughout the year they did not get these epidemics. No doubt cases of diarrhœa did occur, but they were more akin to mild typhoid fever. It was a remarkable fact that diarrhœa as a disease in this country was never epidemic until the pipe-system of water supply was introduced. That water, of course, although it might come from a well, and be perfectly cold at the source, before it got through the mains was heated up, and in the majority of cases the temperature was very high. Greenwich and Woolwich drew their supply from the wells, the temperature of which never exceeded 52°, but it was not at all uncommon in the summer time for the water to be supplied direct from the mains at 66° or even over. There was a marked difference between epidemics of diarrhœa in districts supplied by the Kent Company and those supplied from the Thames. In the latter case the water got warm at the depth of the main, which was usually about 3 feet, and the result was that at the time when diarrhœa became epidemic in districts supplied from the Thames and River Lea the illness was only just breaking out in the Kent districts, but a fortnight later it became developed in those districts, and practically at the end of the year the death-rates from diarrhœa in both of them were almost identical. His own opinion was that a great deal more attention should be paid to these questions of meteorology and disease, and he only wished that a few more medical officers took as much interest in the matter as Dr. Tripe did. A short time ago he had prepared a diagram showing the connection between low ground water and typhoid fever in the case of Croydon, the observations extending from 1866 to the present time, and showing a very marked connection between the two.

The Rev. F. GILBERT WHITE said he had been an observer of meteorology all his life, and so was his father before him. One thing he had observed quite agreed with what Mr. Latham had just said; wherever people would make a rain-water reservoir underground covered over, which he did on the top of Dartmoor, they would be able to have the water cold; there was always a cold dew on the jug and tumblers in which it was used. Not being aware of this theory before, he had not taken any observations with regard to this rain-water tank, but he was quite certain that a great mistake was made throughout the country generally in not taking means to store the rain-water. People would lower their wells, and in many cases ruin their water, because they got dry, whereas for the same outlay they could make a reservoir underground holding 3,000 or 4,000 gallons, and never need run short. There was a great deal of prejudice against rain water, which was quite unfounded. Some people said it might be all right if it were filtered, but he thought that if it were filtered you ran the risk of spoiling it. In Bermuda every one drank water from reservoirs, one of which was attached to each house.

The CHAIRMAN (Mr. J. Norman Lockyer) observed that what had been said in the course of discussion went far to show that his introductory remarks had some truth in them. No one would go away without feeling the important connection between Meteorology and Health, but they must all agree that these studies should go on absolutely *pari passu*, in fact it seemed to him impossible to separate the two subjects. From Mr. Latham's observations with reference to the epidemic at Croydon, it appeared that they not only had to consider the question of temperature so far as the surface of the ground and the air were concerned, but that they must really go below the surface, and deal not only with the temperature of the planet as a whole, not merely climatologically with reference to each particular part of the surface, but also take into account the temperature of the underlying soil and water as well. It was perfectly clear that the sunshine recorder was a very valuable adjunct to the old instruments which had been in use for many years. Personally he should like to see something in addition to that; whether meteorologists would think it possible or practicable he did not know, but there were a great many facts which tended to show that it was important to be able in some way to separate the function of the blue solar radiation from that of the red. Now the sunshine recorder simply dealt with the red rays, which probably was the reason why several gentlemen seemed to hold rather different opinions with regard to it. You could get definite absorption of the red rays by aqueous vapour or by cloud in particular states, and probably that fact would reconcile some of the observations which had been made. Passing to the barometer, they had had several excursions based on Dr. Tripe's remark that at the normal pressure the barometric effect on the human frame was absolutely negligible, but with regard to the effect of some considerable reduction in the pressure, as for instance in going up in balloons, there was one little piece of experience he had in America which might throw some light on the subject. It was well known to the guards on the Union Pacific Railway, that when the train arrived at Summit Station, which was over 8,000 feet in altitude, there was frequently a great deal of malaise amongst the passengers. He had suffered from it himself, and had been a long time away from the gay delights of London, and had suffered no fatigue, having been three days in a railway carriage. So that on that point there was probably something still to be learnt. They were all much obliged to Mr. Symons for the trouble he was taking with regard to the establishment of meteorological stations, and also to those gentlemen who had endeavoured to throw some light on the best kind of observations to be made. It did seem to him very remarkable that in localities which depended for their well-being on having a favourable reputation, so little trouble was taken to show what very favourable localities they were. Some of the first amongst those places were those that had the least rainfall, and a great amount of sunshine, and probably if those who were most interested in the success of those places knew a little more about meteorology, we might have had a flood of information from them many years ago, which would have done both them and science a great deal of good. General Strachey had recently thrown out the idea that it might be a good thing in some cases to shield the thermometer from any effect of direct radiation, so as to be perfectly certain that it registered simply the temperature of the circumambient air, and he, therefore, suggested that some thermometer bulbs should be covered by a very brilliant reflecting surface of silver. It had been found that when they were exposed in that way at equal distances from radiating surfaces there was what fine thermometer readers would call a considerable difference in the temperature record. Every one must hope that the time would soon come when superfluous work in meteorology should be separated from that which was of the highest importance. To arrive at any decision on this point, it would be necessary to have such discussions as they had had that day, and he would conclude by expressing a hope that long after that Exhibition had ended there might be some means provided for dealing with matters of health and meteorology in a much closer connection than they were at present. If any thing of that kind could be brought about it would amply justify the time they had given to this discussion.

A vote of thanks to the Chairman, moved by Mr. H. SOUTHALL and seconded by Mr. BALDWIN LATHAM, having been carried unanimously, the Conference adjourned till the next day.

CONFERENCE ON FRIDAY, JULY 18.

Dr. J. H. GILBERT, F.R.S., in the Chair.

"THE EQUINOCTIAL GALES—DO THEY OCCUR IN THE BRITISH ISLES?" By ROBERT H SCOTT, M.A., F.R.S., President of the Royal Meteorological Society. (See p. 236.)

"SOME OCCASIONAL WINDS AND THEIR INFLUENCE ON HEALTH." By WILLIAM MARRIOTT, F.R.Met.Soc., Assistant Secretary of the Royal Meteorological Society.

THE subject chosen for my paper this afternoon is not a very inviting one, and I fear will be rather dull. But as winds have a great influence upon health—for if there were no wind the atmosphere would be quite stagnant, and we should perish—it may not be unprofitable to turn our attention for a short time to the peculiarities of certain occasional winds.

The earth is surrounded by a thin film of air called the atmosphere. The air allows the sun's rays to pass through it without being much heated thereby; these rays fall upon and heat both land and water, which warm the air resting upon their surface. The earth gets warmed during the day, and cooled by radiation during the night; whereas the sea retains the heat it receives from the sun, and is consequently more equable in temperature than the land.

On referring to an isothermal chart of the globe for January, it will be seen that in the northern hemisphere the air, owing to radiation, is much colder over the continents than over the sea; while in July the reverse is the case. As air expands by heat and contracts by cold, warm air is lighter than cold air. If we now turn to an isobaric chart for the same months, we shall find that over those regions where the air was cold the atmospheric pressure was denser, *i.e.* the barometer reading was higher than where the air was warm, and *vice versâ*.

All winds may be regarded as caused directly by differences of atmospheric pressure, just in the same way as the flow of water is due to difference in level. The air flows spirally outwards from a region of high pressure in the direction of the hands of a watch in the northern hemisphere, and spirally inwards in a region of low pressure in the direction opposite to that of the hands of a watch (The movements are exactly the reverse in the southern hemisphere.) This circulation of the air has given rise to the following simple law for the northern hemisphere—known as Buys Ballot's—viz. "Stand with your back to the wind and the barometer will be lower on your left hand than on your right." The regions of low pressure are called cyclones, and the regions of high pressure anticyclones; the circulation in the former being cyclonic, and in the latter the opposite to cyclonic. The intensity of the wind in all cases depends upon the closeness of the isobars, or lines of equal pressure; for the closer the isobars the greater is the difference in pressure in a given distance, and consequently the stronger the wind.

Now it is the position and movement of these areas of high and low pressure that determine the direction of the prevailing winds. For instance, in winter, when high pressure prevails over Asia, the wind blows out from it in the direction of the hands of a watch, and comes down over India as a North-east wind. This is the North-east Monsoon, and is accompanied by fine weather. In summer, when the distribution of pressure is entirely changed, the wind blows from off the warm Indian Ocean as a South-west wind, and being highly charged with moisture, passes over India as the South-west Monsoon, producing cloud and rain.

The sun's heat is most powerful in the equatorial regions; the air is there so heated that it ascends as an upward current, and air flows in from north and south to supply its place. The winds thus produced do not, however, blow directly as North and South winds, but owing to the rotation of the earth, as North-east and South-east winds. These are the Trade winds. They are constant in direction and steady in force, and only vary in position a few degrees

of latitude, according to the declination of the sun. The region between these two winds is called the Belt of Calms.

Having referred to the prevailing winds, we must now consider some occasional winds, which are for the most part peculiar to certain localities. It may be taken for granted that they are all the result of differences in atmospheric pressure, and the greater the difference, the more violent is the wind. These winds may be divided into two classes, viz. cold and hot. The cold winds usually occur in the winter and spring, and the hot winds in the summer or autumn. We will first consider some of the cold winds.

East Wind.—The wind most dreaded in this country is the East wind, which generally blows in the spring for several days together. It is usually dry, cold, and very penetrating, and is well described in the old saying—

> " When the wind is in the East
> 'Tis neither good for man nor beast."

Dr. Arthur Mitchell, in a " Note on the Weather of 1867, and on some effects of East Winds," says, " Such winds blowing over a moist surface, like that, for instance, of the human body, tend to reduce the temperature of that surface to the temperature of evaporation, which in this case is much below that of the air itself. In licking up the moisture—that is, in causing its evaporation—a large amount of heat is rendered latent. This heat must be taken from something, and, in point of fact, our bodies are, and must be almost its entire source. A cold and dry wind, therefore, cools the surface of our bodies, not simply by enveloping them in a cool medium, and warming itself by conduction at their expense. It does this of course: but, being dry as well as cold, it does it with less activity than it would if moist and cold—damp air being a better conductor than dry air. It is chiefly, however, by the other mode that dry, cold winds abstract heat from our bodies,—that is, by using their heat in the conversion of moisture into vapour. The heat so used becomes latent, and is for the time lost. It does not raise the temperature of the air in immediate contact with the body. On the contrary, that air itself, low as its temperature may be, gives up some of its heat to become latent in the vaporised moisture, and probably gives up more than it gains from our bodies by conduction, so that the temperature of the film of air actually in contact with our bodies may be, and probably is, a little lower than the temperature of the bulk. The quantity of heat which our bodies lose in this way is far from insignificant, and the loss cannot be sustained without involving extensive and important physiological actions, and without influencing the state of health. In feeble and delicate constitutions the resources of nature prove insufficient to meet the demand made on them, and a condition of disease then ensues."—(*Journal of the Scottish Meteorological Society*, Vol. II. p. 80.)

Doubtless nearly all present will remember the very cold, dry, and windy weather of March last year (1883), during a part of which bitter Easterly winds prevailed, especially from the 19th to the 24th. Owing to a brisk fall of the barometer over France, an Easterly gale was experienced over this country. As the temperature was low, and the air very dry, the wind was exceedingly bitter and keen, and its effect upon the human frame very distressing. In consequence, there was a marked increase in the number of deaths referred to diseases of the respiratory organs. The Registrar-General gives the following particulars in his *Weekly Returns of Births and Deaths*:—

DEATHS REFERRED TO DISEASES OF THE RESPIRATORY ORGANS.

Week ending.	Mar. 3.	Mar. 10.	Mar. 17.	Mar. 24.	Mar. 31.	April 7.
Total................	388	395	548	598	672	612
Bronchitis	..	..	349	391	417	379
Pneumonia	..	..	115	146	150	154
Diff. from Average ...	−130	−106	+62	+95	+152	+129

The *Mistral* is a violent North-west wind which blows along the Gulf of Lyons. It is a very dry wind, and cold through its dryness, parching up the country, and withering the leaves of plants by its dessicating influence. It is often sufficiently

strong to blow a man off his horse; and it occasionally overthrows the largest trees, and spreads desolation among the corn and vine crops. The trees generally have their branches twisted in the direction of the current; and, in the places most exposed to its blasts, screens of wood and stone are erected to protect the vines.

It chills the extremities of the body, and often induces dry pleurisy, and pneumonia in weakly persons. In consumptives it is occasionally the cause of blood-spitting. The natives generally complain of rheumatism and vague muscular pains.

The Mistral is caused by atmospheric pressure being low in the Gulf of Lyons, and high in the north; it is most severe when the difference in pressure is very marked.

The *Bora* and the *Tramontana* are both cold winds, similar to the Mistral. They come down from the Alps, and sweep over the Adriatic and neighbouring seas, and are bitterly cold and tempestuous.

The *Northers* or *Nortes*, which occur in the neighbourhood of the Gulf of Mexico from September to March, somewhat resemble the Mistral. They are, as their name implies, Northerly winds, and are remarkably dry, cold, and violent. Mr. R. Russell, in his *North America, its Agriculture and Climate*, states that in Southern Texas, in January 1855, with a Norther, the temperature fell from 81° to 18° in 41 hours; and remarks, "That such great and sudden changes are rendered still more disagreeable by the Northers frequently blowing with extreme violence." With such changes of temperature as this, it is not surprising that these winds have a very pernicious effect upon health and vegetation.

The *Pampero* is a dry, cold South-west wind, which blows with great violence across the pampas of the River Plate of South America. It is most frequent during the spring and summer, from October to January. [Being in the southern hemisphere, the south is the cold point, and so south-west corresponds to north-west at this side of the equator.]

Among hot winds may be mentioned the following:—

The *Scirocco*, which occurs occasionally along the North African coast, Sicily, South Italy, and neighbouring districts, is a hot South-east wind blowing from the heated Sahara. It is apparently a dry wind on the coast of Africa, but on passing over the Mediterranean it absorbs a great deal of moisture, and consequently is a hot moist wind on reaching the south of Europe. In Sicily during its continuance the thermometer sometimes rises to 110° in the shade. This wind receives a very bad character, for it withers green leaves and grapes; it rusts ironwork; it turns meat putrid; paint put on whilst it is blowing will never set; and though not fatal to human life, it is deadly to human temper. It causes a feeling of languor and listlessness, and when it blows strongly it takes all the energy out of a person.

The Scirocco of Spain is called the *Levéche*. It is very hot, dry, and dusty, and is most deleterious to health.

The *Soláno* is an East wind, but it has a bad repute, for the Spanish say, "Ask no favour during the Solano."

The *Harmattan*, which is felt on the west coast of Africa, is somewhat similar to the Scirocco. It is a hot Easterly wind, occurring during the months of December, January, and February. It comes from the hot desert of Africa, loaded with large quantities of fine dust, which are carried far out over the Atlantic and deposited upon the sails and decks of passing ships.

The *Khamsin* is the hot wind of Egypt, and is supposed to last for fifty days, hence its name. It comes as a South-west wind from the hot desert of Africa, and occurs from the end of April till June, at the commencement of the inundation of the Nile.

The *Simoom*.—In a recent paper read before the Royal Meteorological Society, Dr. H. Cook gave an account of the Simoom, a deadly wind which occasionally visits the deserts of Kutchee and Upper Scinde, in common with similarly constituted tracks of country in the East. Dr. Cook says:—

"Sudden, and singularly fatal in its effects, invisible, intangible and mysterious, it has ever been the dread of the desert traveller. So far as I am aware its nature is alike as unknown to the wild untutored inhabitants of the country of which it is a scourge, as to the European man of science. The presence of the Simoom is made manifest by the sudden extinction of life, both animal and vegetable, over which its influence has extended.

"Lieutenant Pastaus mentions it briefly in his report on Shikarpoor, submitted to Government in 1840, as occurring in the district of Kutchee. At the close of the hot weather in 1856 a party of five men were crossing the Put of Shikarpoor, being on their way from Kandahar to that city; the blast unfortunately crossed their path, killed three of them and disabled the remaining two.

"In the year 1851, during one of the hot months, some officers of the Scinde Horse were sleeping on the top of General Jacob's house at Jacobabad. They were awakened by a sensation of suffocation, and an exceedingly hot oppressive feeling in the air, while at the same time a powerful smell of sulphur pervaded the atmosphere. On the following morning a number of trees in the garden were found to be withered in a remarkable manner. It was as if a current of fire about twelve yards in breadth had passed through the garden in a straight line, singeing and destroying every green thing in its course. Entering on one side and passing out on the other, its track was as defined as the course of a river.

"The Moonshi of Major Henry Green, Honorary A.D.C. to the Governor and Political Agent at Khelat, is a native of Bogh, in Kutchee, and gave the following description of the effects of one of these blasts, of which he was both an eye-witness and the sufferer. He was travelling in company with two other persons near Clulgherri, the site of a buried city in Kutchee, about seven miles south-east of Bogh. They were all mounted, when about 2 a.m. the blast struck them. He was sensible of a scorching sensation in the air like the blast of an oven, but remembers nothing further, as all three were immediately struck to the earth. They were carried to Bhag, where every attention was afforded them, and after some days of sickness they recovered. He states that such phenomena are frequent in the desert; that the hot blast is usually preceded by a cold current of air; that it destroys every green thing in its course, and is most frequently fatal to human life. That the bodies of the dead quickly decompose, their flesh is withered, of which the firmness and consistency is destroyed, so that it falls or may be plucked off from the bones; and this not after decomposition has commenced, but immediately on death taking place. The treatment adopted by the natives is at once to wrap up the sufferer in a posteen or warm woollen clothes, and to administer a mixture of onions and pepper with the view of inducing perspiration; if this be established there is a hope of recovery.

"The current passes 'like a knife' through the air, leaving a well-defined narrow track."

In the discussion on this paper Mr. Symons stated that he remembered hearing of a curious case of a hot blast which occurred over a small district in this country some few years ago. A gentleman was walking down to his thermometer screen with the object of examining the thermometers, and had just reached the screen, when he saw the maximum thermometer rapidly go up several degrees, and at the same time he felt a severe pain at the back of his head. He immediately lay down under a tree, and after a little while, feeling better, he got up, and upon going to the thermometer screen again, noticed that close by there was a narrow path cut through the grass, plants, and trees, in which every thing was killed. Mr. Symons visited the place the following year, and then saw the effects of this hot blast.

The *Hot Wind* is one of the most remarkable of the features of the climate of Australia, and is most severe in November, December, and January. Mr. H. C. Russell, in his *Climate of New South Wales*, says:—"In character this wind is the most disagreeable known in Australia, but I cannot agree with the opinions which have been expressed of its unhealthiness. The heat is no doubt great, but it is *very dry*, and to some constitutions affords positive pleasure. The worst general effect that I have been able to trace is languor, and that would certainly be much worse with a moist wind of the same temperature. Vegetable life, however, does not escape with so little damage, and the commencement of a strong hot wind is a signal for all plants to droop; if the leaves are tender, they shrivel up as if frost bitten, and never recover; in extreme cases, stronger plants are injured, and there is one instance on record in December 1828, where a hot wind destroyed for a space of thirty miles all the wheat on the Hunter River.

"The actual temperature of the wind varies from 80° to 110° in Sydney, but it seldom reaches 100°, and only once in twenty years has it reached 106°·9, the

highest recorded temperature at the Sydney Observatory. Inland the heat is much greater, and in Central Australia, Capt. Sturt says his thermometer rose to 131° in the shade on the 21st of January, 1845. The heating effects of this wind are well known, and little protection is afforded by doors and windows, for a house rapidly heats, and it is only the greater heat outside that makes it endurable, which is manifest directly the cool 'burster' displaces it, for the house then feels like an oven."

Dr. Neumayer, formerly Director of the Melbourne Flagstaff Observatory, remarks of the hot wind of January 21st-22nd, 1860, that "the apples were literally roasted on the trees, where the North wind had set in." (Hann, *Handbuch der Klimatologie*, p. 639.)

A similar wind is experienced in South Africa, with almost the same results; in fact, hot winds occur in all countries which are adjacent to deserts.

Dr. Mann informs me that "the hot winds of Natal are distressing, but they are not particularly unhealthy, because they continue to blow for such brief periods without intermission. The most unhealthy wind in Natal is that which comes from the North-east, and which blows parallel to the general run of the coast. It comes from the malarious districts around Delagoa Bay, and is accompanied by a tendency to the development of fevers of a remittent bilious type. This influence becomes more strongly marked along the coast district towards the north-eastern frontier of Natal."

The *Föhn* is a very warm and dry wind, which sometimes blows in winter in the north-eastern valleys of Switzerland. At the time this warm dry wind is blowing in the valleys of the north-east, a warm wet wind blows over the south-west of Switzerland, which precipitates its moisture in a heavy downpour, and floods the country with rain. Mr. Laughton's explanation is better than mine (*Modern Meteorology*, p. 46). He says: "When air is driven or lifted to a great height, as by being pressed up a mountain slope, the expansion of its volume causes a corresponding lowering of its temperature; and the air which approaches the mountains on the west should experience a certain definite loss of temperature whilst being lifted to the mountain-tops, the amount of which may be easily calculated by a reference to the height of the mountains and the diminution of barometric pressure. But if the air is moist, the chilling, to which it is thus subjected condenses the vapour, causing heavy rain on the windward, that is, the western slopes. Now vapour, when turned into water, gives out a great deal of heat: the heat which it has previously absorbed, which gives it molecular energy, and which is very commonly known as latent heat; and this heat set free, warms up the surrounding air; so that the temperature at the mountain-top may be, and is, many degrees higher than, according to the calculation based on the loss of barometric pressure, it ought to be. If now this air, with the moisture squeezed out of it on the mountain-tops, and its temperature raised by the heat of condensation, is forced down into the valley beyond, the increase of pressure as it goes down raises the temperature by an amount depending, as before, on the height from which it has descended, and on the rise of the barometer; so that the air comes into the valley with the temperature due to the level at which it has arrived, increased by the heat conveyed to it on the mountain-tops by the condensation of vapour. The air is thus not only very hot, but relatively also very dry; that is to say, on the descent of the *föhn* the temperature rises at times to more than 80°, and the humidity sinks to about one-fourth of what the air is capable of holding."

Dr. Hann, in a paper read before the Vienna Academy in 1882, gives a discussion of the *föhn* in Bludenz, on the borders of Switzerland and the Tyrol. The most important point is that it is not caused by South-west storms in Italy, for the observations at Milan show "calm" when there was *föhn* in Bludenz. The *föhn* occurs when depressions prevail over North-west Europe. These draw down the *föhn*, but they do not necessarily cause a gale, even at Stuttgart.

Time forbids me speaking of many other winds which are peculiar to certain localities; but, in conclusion, it only remains to point out the desirability of every one, especially invalids, fixing upon a residence that shall be sheltered or protected from cold and dry winds, which are very trying to the human constitution. There appears to be little protection from hot winds.

DISCUSSION.

Dr. R. J. Mann said he might describe his own personal experience of hot winds in South Africa. During several years whilst he resided there he kept a record of those atmospheric phenomena, and found there were twenty-six to thirty in the course of a year. The temperature of the hottest of those South-African winds at any time was 97°, which was quite enough for discomfort, but it was a very dry wind. As Mr. Marriott had stated, as far as the regions inland around Natal were concerned, these hot winds were not unhealthy. The reason for it seemed to be this: these hot winds always began to blow about the middle of the night; you heard the storm come on, which rose in intensity until you became conscious that the house was growing very warm. That continued, and at 9 or 10 a.m. it reached its greatest intensity, when very delicate plants would be killed, and the leaves of evergreens would droop, though after a little while they might recover. About 12 or 1 p.m. the sky, which had up to that time been clear, would be covered over with heavy clouds, and in about an hour there would be a magnificent thunderstorm, the rain pouring down in torrents for five or six hours, and from that time the temperature fell very rapidly, though the wind might continue to blow. He had seen the thermometer sink 30° in less than thirty minutes. This change of temperature was very pleasant, and prevented any unhealthiness occurring from the hot dry wind, and in fact one always welcomed these outbursts. That, no doubt, was the cause of their not being unhealthy—that they invariably occurred in such a condition of temperature that a thunderstorm followed, after which there was generally continuous rain until about the middle of the night. About 1 or 2 a.m. the clouds cleared away; and at an elevation of 2,000 feet above the sea he had seen the whole sky become entirely covered with seventh magnitude stars, which were ordinarily invisible to the naked eye; so that it looked exactly like the Milky Way seen through a telescope. After that they generally got the most delicious temperature the following morning, with a cool, pleasant sea breeze. Now and then, however, it happened that these intermittent winds recurred for three days running, but they were invariably broken by the thunderstorm in the day time, as he had mentioned. A point of his remarks was that these hot winds were not unhealthy, because they were not continuous. The unhealthy wind there, was that which came blowing along from the fever districts in the interior.

Lt.-Gen. R. Strachey said with regard to Dr. Cook's account of the simoom in Scinde, which had been quoted in the paper, to the best of his belief it was greatly exaggerated. Over the whole of India during April, May and June, hot winds prevailed; and, indeed, Scinde being an extremely arid country, hot winds were prevalent. But it must be remembered that Dr. Cook's meteorology was almost pre-Adamite; it was written nearly thirty years ago, when people were not very accurate in observing or in describing what they saw. As a matter of fact Scinde had been occupied, more or less, by British troops and Native troops up to the present time; and during the occupation of Afghanistan, soldiers were constantly passing through the country from the Indus up to Quetta; but as far as he knew, although liable to sunstroke, there was no particular unhealthiness there. There was a liability to severe fever in the autumn, but that was a different thing altogether. The hot winds all over India were rather conducive to good health than to bad health. The exposure to sun and hot wind in aggravated form was liable to bring on sunstroke, but that was not merely from receiving the direct rays of the sun on the body, but the effect of heat generally, which produced a sort of apoplectic condition.

The Chairman (Dr. J. H. Gilbert) said in New York and other parts of America sunstroke was generally developed in the night, not when the person was exposed to the direct rays of the sun.

Mr. G. M. Whipple said the paper was a very interesting one, and it was very desirable to preserve in a collected form for convenient reference a description of these tropical and exceptional winds. He must confess, however, that although he was much interested in hearing an account of these occasional so-called hot blasts, he was rather sceptical as to their being the effect of wind at all. It seemed to him they had no facts, other than these travellers' stories, to lead to

the belief that a current of very heated air could pass through a mass of cool air and yet retain its characteristics for some considerable distance. Of course they knew that a large quantity of air could be set in motion at a time, but there were no facts that he knew of leading them to credit the statement of a hot blast passing along a definite path only a few feet wide. If they looked at the blowing-machinery in the Exhibition, they would see an enormous current of air produced; but it soon got dissipated, and therefore he could not see how a wind could have the characteristic spoken of. There were electrical phenomena, notably globular lightning, which might produce such effects, and he was inclined to think that they must be due to some such cause. Of course it was a very common thing to attribute every thing you could not understand to electricity, but he did not make the suggestion for that reason. The paper contained a great deal of information with regard to the actual cause of the effects experienced physically from different winds, but he should like to know if it were the case that there might be really different climates within a few yards of one another? For instance, people commonly said that the air in one street was very much better than the air in another, and that, putting malarious influences aside—the air might be unwholesome in one house and excellent in another; whereas it seemed to him that the wind constantly blowing must change the air so rapidly as to prevent these great differences. The wind usually blew at the rate of from fifteen to twenty miles an hour; therefore he was unable to agree with those who said the air differed so much in two places, where, if one were to trust the meteorological data, there really could not be any trace of a radical change having taken place in the circumstances of the atmosphere.

Mr. G. J. Symons said it was about fifteen years or more since the facts occurred which were referred to by Mr. Marriott, and he did not recollect the exact circumstances, but his impression was that they did not refer to a blast of air at all; in fact, he had not associated the phenomena with the idea of wind. There was no doubt about the fact, but only as to the explanation, and the impression he had on his own mind was rather—he did not know whether it were possible or not—that there might be a cloud of such a shape as to focus the sun's rays on one particular point. The impression he had was that of a path of heat rather than a current of air. With respect to the remarks made as to the difference between one street and the next, he believed Mr. Whipple was not present on the previous day, when the discussion rather turned on that point; and it was stated, with reference to the number of meteorological stations it was desirable to have, that in many cases, such as High Harrogate and Low Harrogate, and different parts of the borough of Hastings, two places close together might be characterised by differences quite as great as in other circumstances would be noticeable only at a distance of twenty miles. Take, for instance, such a town as Dover, with some houses on the cliff and some under the cliff. Those immediately below the cliffs, when the sun was shining straight upon them, and without any wind, would be something like an oven; but when the sun passed over, and the wind sprang up, the temperature would be very different indeed. He could not agree with Mr. Whipple, that there were no differences except from currents of air; in fact, one of the great reasons why there were differences in climate was, that the wind blew in one place and did not blow in another. They knew, for instance, that if they wanted to put up an anemometer to measure the current of air passing over, the great majority of towns offered no position in which they could possibly put it, simply because the wind did not get into the streets at all to sweep them out properly. If it were not wandering too far from the subject, he might mention that it had been strongly urged, with reference to the building of new streets, that it was very desirable as far as possible that the main lines of a town should coincide with the prevailing direction of the wind in that town, in order that the streets might be thoroughly "air-scavenged." Under ordinary circumstances, the velocity of wind in a town was not sufficient to counteract the effect of local circumstances on the atmosphere in it.

Mr. W. Marriott, in reply, said he had given his authorities for the theories and statements quoted in the paper, and he was not responsible for them. With regard to the question, whether currents of air only a few feet in width were possible, he would remind them of the remarkable tornadoes and whirlwinds which sometimes occurred, when they heard of a forest or plantation being cut through as it were—the trees being cut down over a small area only, and the

line being very sharply defined. If that were possible with a tornado, he did not see why it could not also occur with a hot wind.

"CUMULATIVE TEMPERATURE." By ROBERT H. SCOTT, M.A., F.R.S., President of the Royal Meteorological Society.

ON the walls of the Meteorological Annexe will be found a series of diagrams, exhibiting from various districts in the United Kingdom, in a graphical form, the march of Temperature, Rainfall and Bright Sunshine, from the beginning of the present year, and also for the entire year 1881, which is reproduced for purposes of comparison. (See Diagram, p. 298.)

The object of these curves is to show clearly some of the most important factors in the growth of crops. Now, as to the growth of crops, our chairman, Dr. Gilbert, F.R.S., is admittedly one of the highest living authorities, as, in conjunction with Sir J. B. Lawes, Bart., F.R.S., he has for many years conducted with scrupulous accuracy extensive investigations into this subject at the famous experimental farm of Rothamsted. Let us, therefore, hear what Sir J. B. Lawes and Dr. Gilbert have to say:—

"On this point we may remark that we have found the really most luxuriant and heavy crops, both of hay and of wheat, to have been very materially influenced by the characters of the winter and early spring periods,—*quantity* in both cases depending very greatly on the early development of the plant. With favourable conditions in this respect some of our very heaviest crops, both of hay and wheat, have been obtained under by no means specially favourable meteorological conditions during the period of the most active above-ground growth. On the other hand, high proportion of corn to straw, which sometimes gives really high yield per acre, depends more upon the conditions of the periods of active above-ground growth and maturation. In the same way, great weight of hay sometimes depends upon the conditions of maturation rather than of luxuriance.

"It is obvious, therefore, that in discussing the relations of meteorological condition and agricultural production, it is essential to be able to arrange the records for any selected periods of the year."

And again:—

"It is obvious that different seasons will differ almost infinitely at each succeeding period of their advance, and that, with each variation, the character of development of the plant will also vary, tending to luxuriance, or to maturation, that is, to quantity or to quality, as the case may be. Hence, only a very detailed consideration of climatic statistics, taken together with careful periodic observations in the field, can afford a really clear perception of the connection between the ever-fluctuating characters of season and the equally fluctuating characters of growth and produce. It is, in fact, the distribution of the various elements making up the season, their mutual adaptations, and their adaptation to the stage of growth of the plant, which throughout influence the tendency to produce quantity or quality. It not unfrequently happens, too, that some passing conditions, not indicated by a summary of the meteorological register, may affect the crop very strikingly, and thus the cause will be overlooked, unless careful observations be also made, and the stage of progress and tendencies of growth of the crop itself at the time be likewise taken into account."

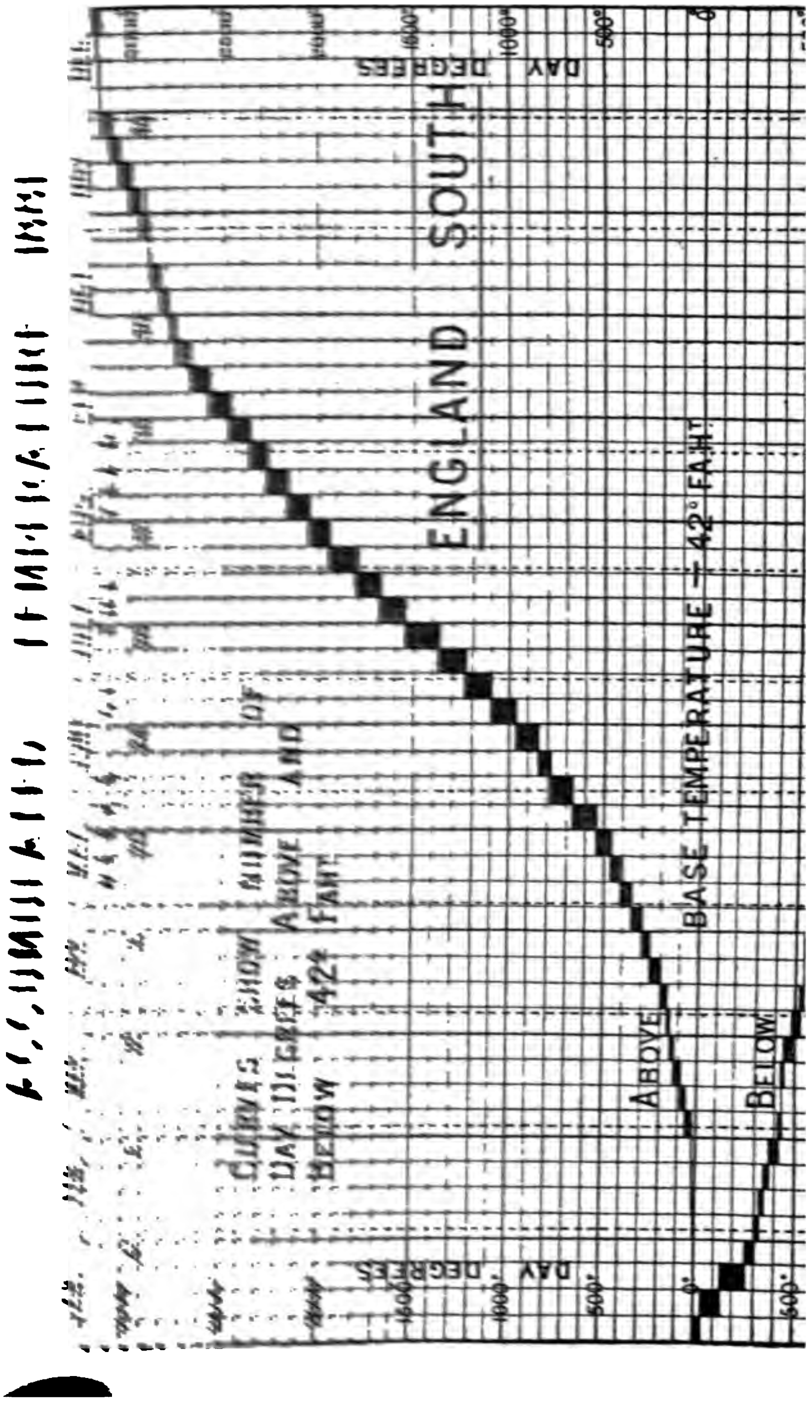
Again—

"Those characters of season which are very unfavourable for land in poor condition, may be favourable to land in high condition, and *vice versâ*."

As regards the three elements represented on the diagrams, it is evident that the curves for rainfall and sunshine require but little explanation, as the successive steps of the curves show the successive weekly totals of rain or sunshine.

The case as regards temperature is however different, and those who examine the diagrams will see that there are two curves, one ascending, the other descending; the one red, the other blue. A certain arbitrary base line is assumed, and the values are measured above or below that line.

It is proved almost beyond doubt that each plant, say each individual cereal, requires a definite amount of heat to bring it to maturity. Thus maize requires more than wheat, and wheat again more than barley or oats.


CURVES SHOW NUMBER OF DAY DEGREES ABOVE AND BELOW 42° FAHT.
ENGLAND SOUTH
BASE TEMPERATURE — 42° FAHT.
ABOVE
BELOW
DAY DEGREES
DAY DEGREES
1500°
1000°
500°
0°
500°

We all know that maize is not an English crop at all, and that wheat is not grown to much profit in Ireland or the West of Scotland, being replaced by oats or barley. The ordinary reason assigned for these differences as to crops is that in each case the temperature is not high enough for the particular crop which has failed. If the inquirer pursues the subject further he generally finds out that his informant has no very precise idea as to how the temperature acts.

Now various investigators, and notably Boussingault and Professor Alphonse de Candolle, of Geneva, have devoted much attention to this subject; and the latter writer, in his *Géographie Botanique*, has come to the conclusion that a certain total amount of temperature above a definite base line is necessary for plant growth, and that this amount, or, as he calls it, this "sum of temperature" varies for each crop.

He found that plants, as a rule, did not begin to give indications of active vegetation until the temperature rose above 6° Cent. This temperature, 6° Cent., or, in round numbers, 42° Fahr., that is ten degrees above the freezing point, is taken as the base for all the diagrams.

Although Professor de Candolle propounded his views some years ago, yet, as recently as the year 1874, at the Agricultural Conference at Vienna, meteorologists were quite at sea as to how these sums of temperature were to be calculated.

The credit of solving this problem belongs to Lieut.-General Richard Strachey, the Chairman of the Meteorological Council. He proposes to adopt a certain unit of temperature to supply a standard for calculation, the unit being one degree continued for the unit of time, either one hour or one day, as the case may be. Such a unit may be conveniently called an hour degree, or a day degree. The unit of time adopted for the calculations to which I am about to refer is a day, and the unit of what may be termed the effective temperature is, therefore, *a day degree*. A day degree, therefore, signifies 1° Fahr. of excess or defect of temperature, above or below 42°, continued for twenty-four hours, or any other number of degrees for an inversely proportional number of hours.

Now the first idea I want you to take in about these day degrees is that when we speak generally of the mean or average temperature for a day, or month, or year, we imply that the resulting temperature is the same as would be observed if the thermometer indicated this mean temperature throughout the entire period for which the mean is taken. Thus, if we were dealing with daily means, an average daily temperature of 62°, which is an ordinary temperature for a warm summer's day, would indicate twenty day degrees of temperature for that day, starting from the assumed base line of 42°, which has already been mentioned.

The first step, therefore, towards determining this effective temperature in day degrees resolves itself into determining as speedily and simply as possible the average temperature for the period under consideration.

We have, fortunately, to our hands a very simple mode of arriving at the mean temperature with accuracy sufficient for our purposes. Almost all observers record the maximum and minimum temperatures once in the twenty-four hours. It is found that the half sum of these readings, the mean between them is nearly but not exactly the average for the day.

The next points which require attention are: whether the maximum and minimum are both above 42°, which occurs in summer; or both below that point, which occurs in winter; or, finally, whether one is above, and the other below.

In the first case all the accumulated temperature is to the good; it is all on the positive side. In the second case it is all on the negative side. The third case is the only one which presents difficulty, for when the extreme temperatures are on either side of the line of 42°, one portion of the effective temperature for the day is positive, and the other negative.

Now, General Strachey carried out a long series of calculations, based on the observed hourly temperatures at Kew Observatory, and at other stations in the United Kingdom, in order to ascertain the magnitude of the co-efficient by which the difference between either of these extreme temperatures and the base temperature (42° Fahr.) should be multiplied in order to obtain the values of the temperatures in excess or defect of 42° expressed in day degrees, and he found that this, *for a weekly period*, was 0°·4.

Accordingly we get the following rules:—

If the mean of the day is above 42°, we multiply the difference between the minimum and 42° by 0°·4, and call this *the negative effective temperature.*

To find *the positive effective temperature* we subtract from the difference between the mean for the day and 42° the negative effective temperature just determined.

If the mean of the day is below 42° the proceeding is similar; but we first ascertain the positive effective temperature, and subtract that from the difference between 42° and the mean, thus obtaining the negative effective temperature.

The method of determining the effective temperature, which may briefly be called the accumulated temperature, is fully explained in a paper by General Strachey, which will appear in the forthcoming volume of the *Quarterly Weather Report*, that for 1878. Meanwhile it is extremely interesting to examine the diagrams in the Annexe somewhat minutely, and to observe how the total accumulated temperature, say, up to July 1, is made up in very different ways in the two years, 1881 and 1884, there exhibited.

The year 1881 was very cold in the winter, and its accumulated temperature was made up in the spring and early summer. (See Diagram, p. 298.) In the present year we had practically no frost, but then we had unusually cold weather at Easter and at the end of May.

The practical application of the data thus obtained as standards of comparison for the growth and ripening of various agricultural products must, of course, be left to the agriculturists, and it will be interesting to learn how far a correspondence between the character of the several crops and the accumulated temperature of the year can be established.

The measure of temperature afforded by this system of computation appears to be as well suited to supply a standard of comparison of climates for hygienic purposes as for agriculture, and the diagrams indicate in a forcible manner the characteristic differences of climate, in respect of temperature, of the portions of our islands to which they refer.

Thus it will be seen that since the 1st of January of the present year, while there have been nearly 400 day degrees below 42° in the north of Scotland, in the Channel Islands there have only been 9 such day degrees; also that in the former district the day degrees above 42° have been only 726, as compared with 1,500 in the Channel Islands.

DISCUSSION.

The CHAIRMAN (Dr. J. H. Gilbert) said he had been very much interested in this *resumé* of a very important subject, which he thought would have to be very much more considered than it had been of late, and much credit was due to the Chairman of the Meteorological Council, for the great care and attention he had given to the means of getting these records into a practical shape for consideration.

Lt.-Gen. R. STRACHEY said it was very easy for those who were conversant with this subject to take it all in on hearing the paper read, but there might be some present who had not quite followed what Mr. Scott had been saying, and therefore he would endeavour to illustrate on the blackboard the method by which the results were obtained.

(He then drew a diagram, showing the curve of temperature for twenty-four hours, with lines representing the maximum, minimum, and mean, and also the temperature of 42°, which was taken as the datum, and showed the manner in which the calculations were made.)

He said the process was an extremely simple one, and the calculations also were very simple. He had worked out for Dr. Gilbert some time ago the data for 1881, and also for 1882, and he had them now for the present year; comparing the results for the south of England down to July 7th, he found that the accumulated temperature to that date was 1376°; in 1882, up to July 10th, it was 1403°; in 1881, up to July 4th, it was notably less, namely, 1100°; on July 11th, it was 1200°. Therefore, it was decidedly less in 1881 than 1882 and 1883. To show the difference between the south of England and the north of Scotland, he might say that at the present time at the north of Scotland the accumulated temperature was 726° as compared with 1376° in the south of England. By comparing these figures it was easy to see how the total rose as you came south. For instance, on July 4th, in 1881, in the north of Scotland the total was 751°, which corresponded to a result about five or six days earlier in the north-east of England, to about a fortnight earlier in the east, to about three or four days more in the midlands,

and to nearly three weeks earlier in the south of England; so that it gave an indication of the relative difference in time during which different parts of the country received the same quantity of heat, and probably if the thing were carried out fully it would give some sort of indication of the relative period at which the crops would ripen. They were much indebted to Dr. Gilbert for having raised the question, and induced them to go into this subject, and also for pointing to another very important subject, namely, the moisture in the air, and the manner in which that was effective. He had been taking up that question also, and hoped before long to be able to produce diagrams analogous to the one now shown illustrating that point. He quite agreed with Dr. Gilbert that the manner in which the moisture was indicated at the present time was not to be trusted, and that something altogether different was necessary in order to judge of the effective moisture in the air.

Dr. R. J. Mann said they were much indebted to General Strachey for the mathematical calculations he had gone into, which enabled all these interesting facts to be put on a diagram which every one could understand. He had been much puzzled at first to understand it, but he saw in the course of a very little while what a marvellous power it was which enabled a few calculations with figures to be brought down to a certain result, and made available to illustrate a familiar principle. It was a remarkable illustration of the value of the diagrammatic mode of treating an occult subject, and making it accessible to general intelligence.

The Chairman (Dr. J. H. Gilbert) said Mr. Scott had referred in the paper to Boussingault, and others on the Continent, who had gone into this question. It was de Candolle who had originated the idea of making these calculations, but how far he had carried them out he had not been able to ascertain. Boussingault, who had travelled very much both on the European Continent and America, tried to calculate it with the view of determining what localities were suitable for different crops; and to illustrate it as far as wheat was concerned, he took half-a-dozen localities in South America, and four or five in Europe, but the only means he had were to take the recorded mean temperature, whatever that might mean, and the number of days which he estimated the crop took, from its appearance above the ground, to ripening, and multiply the one by the other, and thus he obtained his aggregate number of degrees of temperature recorded for the growth of wheat. These figures were calculated, not as they were now doing from 42°, but practically from 32°, for he took all the degrees above 0° Cent., and multiplied them. His results converted into the Fahr. scale gave something considerably over 2000° record for the ripening of wheat. Hervé Mangon, in France, took another mode. He discarded all temperatures below 42°; but if the temperature exceeded 42° he took it down to 32°, and his figures came out considerably lower than those of Boussingault. Now he (the Chairman) tested some twenty-eight years of experimental wheat growth, and taking the dates when he considered the temperature was that of fair growth, and taking it up to the date of cutting, which in one case was August 28th, he got the average of 1970° Fahr. over 42°. That was using only the mean monthly reported temperatures. For about six years they were able to take the daily temperatures, and in that case it came to 7010°. With regard to those years to which General Strachey had referred, he gave his results for 1881 and 1882 calculated by the same method, which was very much more exact as giving the ruling temperatures of the twenty-four hours. They took merely the mean temperatures as calculated in the ordinary way. In the case of 1881 General Strachey's method gave 1623°, whilst taking the recorded mean it came to 1664°. In 1882, which was a year of very much more growth in the early stages, that was to say, there was a great deal higher temperature before the date at which they commenced, whilst General Strachey's figures were 1525°, theirs, taking the mean recorded temperatures, were 1573°. He believed, according to the factors which General Strachey had worked out, that in the winter there was very little difference in the figures taking the mean temperatures in the ordinary way, but in the summer the ordinary mean was too high by some degrees, and the result was that in these calculations they found General Strachey's figures by the reduced mean came lower than reckoning in the rough way they had been able to do before. Now it was a very important question to settle how far these facts would be of use or not. He had some hopes given him by General Strachey

that they would be able to carry back these calculations for a number of years, so that they might be compared in characteristic years of produce; but until that was done they really could say no more than that it was exceedingly important to try how far these facts when ascertained would be of general utility or not. But he might illustrate the tendency of the thing very much in the same way as General Strachey had done. He had taken up to the end of the first week in July the amount recorded of accumulated temperatures up to the present time, and had arranged the districts in England as given by the Meteorological Office in the order of the highest: the South, 1376°; Midland Counties, 1370°; England east, 1316°; England north-east, 1085°; Scotland east, 1036°. These were the corn-yielding districts, as they were classed in the meteorological records. Here they had by the same data 1¼ times as much effective temperature in the south, midland and east of England as in the east of Scotland; in fact, the order in which the accumulated temperatures came was really the order of harvest dates. He might say also that the order was the same for those five districts for the three preceding years. In their own district they had nearly 1400° of accumulated temperature up to the present time, and he believed that their wheat harvest, about twenty-five miles from London, would be earlier than usual, in fact he should not at all wonder if it took place before the end of the present month. Mr. Scott had quoted a statement of his own, that the highest yields, independently of quality, whether corn or straw, with the greatest amount of luxuriance were always after mild winters, and this was most strikingly the case up to a certain date this year, for he told several people who asked his opinion that they would have one of the heaviest crops of wheat or of hay for many years if the succeeding temperature or rainfall were favourable. Now for the Eastern, Midland and Southern Districts they had an excess of temperature almost from the date of last harvest up to the beginning of April, and then there were four or five weeks of very disastrous low temperature, much below the average. The result had been that in their somewhat heavy land the wheat still showed very heavy, with recent rains as heavy as that it had gone down; but the grass was on the other hand entirely checked with the long period of low temperature associated also with great dryness, so that they had poor hay harvests, but there was a promise of a very heavy wheat produce on any thing like heavy lands; owing to the great deficiency of wet the light lands had been suffering, but so far as the heavy lands were concerned, the very mild winter would result in a large amount of growth. How far these breaks would interfere with any thing like uniformity as to the total amount of accumulated temperature required for the individual crops they would have to find out. Then again, each plant and almost each plant function had its degree of temperature below which there was no growth, so that there was a great deal yet to study even when they got the facts. There was one other point he would refer to, though perhaps the remark would not be very welcome at the Meteorological Office. They were now receiving every week a record of the accumulated temperature for that week, and of the accumulated temperature from the beginning of the year; but to study the history of the year or the history of the growth it was necessary to post all those up week by week, and it would be very useful, therefore, that they should have attached to the returns the amount for every week of the year, so that they might fill them up as they came. They would then have the accumulated temperature excess or deficiency for every week before their eyes for the period they wished to study, and the accumulation at one view. It might be too much to ask the Office to undertake that, but it would greatly facilitate a study of the facts.

He concluded by moving a vote of thanks to Mr. Scott for his paper.

Mr. R. H. Scott said he had to express his extreme satisfaction that this short paper had produced very valuable remarks from General Strachey and the Chairman, who had paid so much attention to the subject.

A vote of thanks to the Chairman, moved by Mr. R. B. Grantham and seconded by Mr. S. Rostron, terminated the proceedings.

CORRESPONDENCE AND NOTES.

Stanley's Meteorologists' Rule.

Mr. W. F. Stanley has presented one of these Rules to the Society, of which he gives the following description:—

As every meteorologist who aspires to more than a local idea of the science meets constantly with the systems of measurement used elsewhere than in Great Britain, it is useful to be able to compare immediately other standards of meteorological measurements with our own. The Rule presented to the Society has on one side a scale from 26 to 32 inches, which gives comparative values at all points of barometrical readings in inches and centimetres. To fill up the space on this side a scale is taken from Mr. Symons's *Pocket Altitude Tables* for correction of altitude and temperature, also a table of the values of Beaufort's scale in lbs. pressure and velocity of the wind. The reverse side of the Rule contains comparative temperature values of Fahrenheit, Centrigrade, and Reaumur, so that temperature values of any one of these scales may be compared with the others at sight.

Added to the Centigrade scale are certain figures which indicate a method the author has found convenient for taking Centigrade degrees by a constant *plus* reading. This he has, however, been informed since he made the present scale was in use by Admiral FitzRoy. These constant *plus* reading figures are put in red, and placed vertically, so that they do not in any way interfere with other readings. All readings by this method are made *plus* 100°, so that 0° is 100°, + 10° is 110°, —10° is 90°, and so on. Mr. Stanley has found this method to effect a great saving of time in taking means in a work upon which he has been engaged several years. All columns are simply added up, and after being divided by the number of observations, two figures are cut off, (equal to dividing by 100), which gives the decimal parts. This method, besides being a great saving of time, is less perplexing than + and — signs in addition, and saves the space of the signs in the column.

Remarkable Hailstorm.

Extract of a Passage from the Annals of the Resuli Dynasty of Yemen in South Arabia. Unique Manuscript belonging to the Library of the India Office (No. 1311, folio 158 recto, lines 3-11). Translated by J. W. Redhouse, Litt. D., M.R.A.S.

"And in this year (A.H. 695, A.D. 1295-6), in the month of Jumāda-'l-awwal (5th month, about March), there fell in Yemen a rain embracing the whole country. And there was in it a great hailstorm that killed a great number of sheep and goats. There fell then a hailstone as large as a small mountain, with projecting points, each above a cubit (30 inches, about) in length. It fell on a moor between the districts of Sinhān and Rāha. The bulk of it disappeared in the earth, leaving a part visible above the surface. Twenty men could walk round it, who could not see, some of them, some of the others. Another fell in a place near to the country of Khawtan, the heart of which forty men tried to lift, but were unable. A letter from the governor of Rāha, addressed to the Imām Mutahher (Prince of North Yemen then) gave him an account of the rain in which the hail fell.

"It was a marvel of the kingdom of the heavens and the earth. Glory to Him whose might created and whose wisdom originated it."

Meteorology of the Congo.[1]

The following abstract of Baron Von Danckelman's paper is restricted to the observations made at Vivi. This town was one of the first stations founded by Stanley, and is situated on the right bank of the Congo, where the river ceases

[1] *Mémoire sur les Observations Météorologiques faites à Vivi* (*Congo Inférieur*) *et sur la Climatologie de la côte Sud-Ouest d'Afrique en général.* Par Dr. A. Von Danckelman.

to be navigable on account of the Yellala rapids. It is distant from the sea by about 180 kilometres (112 miles) as the crow flies, flowing at Vivi between chains of rocky mountains, or rather narrow plateaux, rising to an altitude of 300 metres, and covered with long grass and shrubby trees.

Its longitude is about 13°49′ East of Greenwich, and latitude 5°40′ South. The altitude of Vivi (Lower Congo) above the sea, calculated from the results of different observers, is 113·4 metres.

The observations mostly extend from May 1882 to May 1883, so that although interesting as far as they go, they cannot be considered as giving an accurate knowledge of the climate of Vivi.

The instruments appear to have been carefully exposed, and the results obtained may be expressed as follows:—

The Temperature. The annual maxima correspond to the two greatest altitudes of the sun on March 6th and October 8th. The two minima occur in July and December. A cold portion of the year, during which time the mean monthly temperature is below the annual mean, includes the period from June to September. In the Lower Congo the season extending from the middle of June to the middle of September is undoubtedly the pleasantest, the finest and the healthiest of the whole year. The few days entirely overcast allow of excursions or shooting parties, while breaking the monotony of life. A blue veil of dry fog spreading over the landscape, the yellow grasses, the many bare trees, the silence of nature alone interrupted by the cooing of wild pigeons, have a peculiar charm, and recall the fine autumnal days of central Europe.

At Vivi the coldest day of the whole period the observations refer to was July 11th, 1882, when the mean temperature of the day reached only 64°·5. In cloudless nights the temperature falls considerably, thus it registered only 53°·6 on July 29th, 1882. During the dry season in 1882 it fell nine times to 59° or under; in 1883, this occurred only four times. The hottest day was November 4th, 1882, with a mean temperature of 83°·1; the highest maximum, 97°·1, was registered on November 5th, 1882.

The temperature of the earth at Vivi was observed in the soil of a small cave or fissure in a rock on the north-east of the hill on which the station is built. A thermometer was driven into it to a depth of 25 centimetres, and read at least once a month. The mean of the observations made at the beginning of each month amounts to 77°·7.

The temperature of the Congo river near Vivi, taken between 8 and 9 a.m., varied from 77°·7 in September 1882 to 84°·0 in April 1883, throughout a period of eighteen months.

The Humidity exhibited great variations throughout the year, and at times a state of great dryness of the air at Vivi has been observed; on February 4th, 1883, for instance, the relative humidity registered was 35 per cent., indeed this was the lowest degree of humidity recorded.

Clouds. The author remarks that in the dry season cumulo-stratus indistinctly limited is often caused by prairie fires, these occurring yearly in the dry season throughout the whole of tropical Africa. In the Lower Congo, these fires break out in May immediately after the wet season and last till November; and they reach their maximum in September or beginning of October. At night the sky is often red in five or six places from the reflected light of the conflagration. The destruction of grass from fire must be very great indeed, and it is computed to amount to 609 millions of tons for that part of the African continent between the Equator and the Tropic; or, deducting lakes, rivers, marshes, &c. there would still remain 567 millions of tons of dry grass destroyed by fire.

With reference to the effect of the fires on the climate, the author does not agree with Cameron, who considers them as occasioning slight partial showers of rain. It is possible, the author observes, that according to the views of Coulier, Mascart and Aitken, the smoke particles exert an influence in the formation of clouds, not only on account of the very large volume of smoke emitted, but from the influence of the particles on aqueous vapour, and its condensation in small liquid globules.

At Vivi the atmosphere was at times so full of smoke, even when there was no fire in the neighbourhood of the station, that it became no longer possible to see the heights in the south-west; the air conveyed a smell of burning vegetable matter, and there fell quite a rain of ashes and calcined grass.

There forms in the air over these fires large grey-white cumulus, in which electrical phenomena may be observed; thus the author noticed on October 30th, 1882, flashes of light and lightning in a cumulus hovering over an extensive prairie conflagration to the East of the station.

Days and nights fine throughout are rather scarce, and even in the absence of clouds there is so much vapour in the air that a fine clear night with bright stars is an exception. During the period extending from February 1st to 12th, the light reflected from the soil was so powerful, that several of the Europeans inhabiting the station of Vivi suffered from affections of the eyes.

Direction and Force of the Wind.—From June to October or during the dry season, the general direction of the wind at Vivi is from the South-west quarter. It is only in the first hours of the morning, and sometimes also in the evening during the wet season, that a slight breeze may be noticed from the North. This phenomenon which is quite local, is due to the chain of mountains north of the Station. Westerly winds also predominate throughout the wet season, although usually much less strong. Stanley has observed that from the beginning of February till March there exist in the Bangala country from the 2nd degree north latitude to Stanley Pool excessively strong South-west winds, often blowing a gale. This same wind was the cause of an accident near Bolobo, in June 1882, when two of the members of the International Expedition were drowned in the Congo.

The strength of the wind at Vivi exhibits diurnal and annual periods of variation sharply defined. As to the former, in general there is very little movement of the air shortly after sunrise, so that during the rainy season, to which this remark mainly applies, three-quarters of the morning observations record calm. It is only at 10 or 11 a.m. that a slight breeze is noticed, increasing progressively till 3 p.m. Then a phenomenon may be observed apparently characteristic to the South-west of Africa, especially during the dry season—that is, the occurrence of strong winds in the evening and at night. This wind often attains a force great enough (5-6, according to the Beaufort Scale) to shake the wooden buildings. In its annual variations the wind reaches its maximum of force in September or October; however, a secondary maximum is observed in May, especially at noon and in the evening. Three minima fall in April, June and December. The existence of a double period of the annual force of the wind is likewise shown by observations made at other stations, such as Loanda.

Rains.—At Vivi the months of November and April were attended with the heaviest rains. The rainy season ceased on May 12th, 1882, with a heavy storm. The first actual rain fell afterwards, on October 4th, followed by a strong storm-shower on November 10th. The rain continued from that time with intervals of one or two dry days until November 27th. Then they ceased till December 6th. From December 27th to January 11th the weather was again dry, with only 0·08 in. rain. The weather remained completely dry from January 20th to February 16th. In March there were several intervals of dry days between the rainfalls, but in April rain fell more continuously. The rainy season of 1883 came to an end on May 6th.

Rain in those regions occurs nearly invariably in the form of storms and showers; rains lasting several days in succession, as in Europe, were not observed. It never happened that work carried on out of doors had to be interrupted for a whole day on account of the rain.

At Vivi rains are nearly always accompanied by electrical phenomena. More northerly, under the Equator in the Gaboon and Camaroon, for instance, there are heavy rains without any electrical display.

The frequency of the showers appears to increase from the coast to the interior. Hail is unknown on the coast, but has been observed by Stanley and others at Stanley Pool during a storm.

Periodical Changes in the Depth of the Congo.—These changes depend on the rainfall, and are considerable in extent. A difference of level of 9 metres is observed near the rapids between Stanley Pool and Issangila, of 4 or 5 metres at Vivi, and of hardly 1 metre at Ponta da Lenha. The rise from local rainfall appears relatively small, but that which is caused by Northern affluents commenced in 1883 on August 1st, and in 1882 on July 28th. On October 19th the water was at least 3 metres above the mean level, or level lasting longest throughout the year, which is shown by a white mark the deposits leave on the rocks.

The river continued rising till December, and reached its extreme height that month between 5th and 15th. From December 30th the river's level fell rapidly; and a month later, on January 31st, it had subsided by 2¼ metres.

Storms.—The influence of storms on the barometer could not be ascertained without self-registering apparatus, but in many cases forecasts of storms were obtained from the weathercock. When the vane points to the East instead of the usual South-west, the change is nearly always followed, a few hours later, either by a storm or by threatening clouds, showing that a storm has occurred in the neighbourhood.

Storms from the East or North-east are most frequent, those from the North-east are generally the strongest. The approach of the storm-wind is easy to foretell. Behind heavy dome-shaped storm clouds a segment of uniform grey may be seen to rise, corresponding to the rain-area. The air is calm or a light South-west wind blows until the cloudy segment has attained a height of about 70° above the horizon; then the North-east wind rises in sudden gusts, houses shake and clouds of dust arise, a few drops of rain fall, and then the hurricane blows for ten or twenty minutes attended with torrents of rain. Its violence subsides, however, very rapidly, whilst the rain and electric discharges last some time longer. Some times a succession of storms happen on the same day from different directions.

The storms observed at Vivi during the rainy period 1882-83 were attended with much more lightning than storms are in Europe, though with less roll of the thunder.

Lightning was often seen in the horizon in the evening; and distant thunder often heard without their being any storm at the Station. A feeble electric illumination of the clquds was observed several times in stormy nights.

On the Congo, heavy rains are invariably accompanied by electrical phenomena of varying frequency.

RECENT PUBLICATIONS.

AMERICAN METEOROLOGICAL JOURNAL. A Monthly Review of Meteorology and allied Branches of Study. Vol. I., Nos. 5-6, September-October 1884. 8vo.

This is a new publication, commenced in May, and edited by Prof. M. W. Harrington. It is stated to be the only Journal in America devoted exclusively to the science of Meteorology. The principal articles in Nos. 5 and 6 are:—The Frost of late May (3 pp.).—Finley's Tornado Predictions, by G. K. Gilbert (6 pp.).—Tornado generation, by H. A. Hazen (4 pp.).—Atmospheric Lunar Tides (3 pp.).—Thermal belts, by J. W. Chickering, Jun. (6 pp.).

ANNUAIRE DE LA SOCIÉTÉ MÉTÉOROLOGIQUE DE FRANCE. Vol. XXXII. January-March 1884. 4to.

The principal papers are:—Sur le relevé des temperatures minima, par P. Cœurdevache (1 p.).—Sur la variation diurne du baromètre à différentes altitudes, par C. André (3 pp.).—Théorie des variations brusques que présentent les courbes du baromètre-enregistreur pendant les orages, par M. Cousté (4 pp.).

ANNALI DELL' UFFICIO CENTRALE DI METEOROLOGIA ITALIANA. Serie II. Vol. IV. Parts I.-III. 1882. 4to. 1884.

Part I. (292 pp.) contains the Report of the Council and various papers on meteorological and magnetic subjects, viz.:—Modificazione dell' Igrometro ad Appannamento e cenno storico di questo apparecchio, del Dr. C. Chistoni (14 pp. and plate).—Pioggia a differenti altezze, del Prof. D. Ragona (11 pp.).—Sulla variazione media della temperatura in Italia con la latitudine ed altezza, del Dr. A. Lugli (29 pp.).—Ricerche sulla teoria matematica dei venti, del Dr. L. de Marchi (19 pp. and plate).—Sul clima di Como, del Prof. G. Gambara (49 pp. and plate).—Primi risultati statistici sui presagi del tempo fatti nell' Ufficio Centrale di Meteorologia in Roma, del Dr. A. Lugli (12 pp.).—Relazione tra alcuni elementi meteorici ed i prodotti della Campagna in Italia negli anni 1875-79 e

1880-82, del Dr. C. Ferrari (48 pp. and map).—Sulla variazione annuale di temperatura delle acque del Golfo di Napoli con un' appendice sulle temperature estreme diurne nell' Ottobre 1879.

Part II. (738 pp.) contains the daily, monthly and annual results of the observations made in Italy during the year 1882.

Part III. (244 pp.) is devoted chiefly to astronomical subjects; it also contains the observations and monthly review of the weather at the R. Osservatorio del Collegio Romano for the year 1882.

Annual Report of the Board of Regents of the Smithsonian Institution for the Year 1882. 8vo. 1884. 855 pp.

The General Appendix contains summaries of scientific discovery in particular directions. The article on Meteorology (93 pp.) has been prepared by Prof. Cleveland Abbe, and presents a summary of progress during the years 1880-1882.

Bollettino Mensuale Pubblicato per cura dell' Osservatorio Centrale, del Real Collegio Carlo Alberto in Moncalieri. Serie II. Vol. IV. Nos. I.-III. January-March 1884.

Contains:—Note sull' Eliofotometria di Pier Francesco de Horatiis. The author describes and recommends the adoption by observers of a photometer similar to Roscoe's for the determination of the actinic power of the sun's rays by means of the discolouration of strips of sensitized paper. No results are given, and the paper consists mainly of suggestions for the improvement of Prof. Craven's instrument.—Istruzioni per le Osservazioni sul Mare e sulle Brezze.—Sulle variazioni di temperatura secondo le altezze del Prof. Giuseppe Roberto. The author believes he has found a law governing the diminution of atmospheric temperature with height above the Earth's surface, analogous to Laplace's law with reference to barometric pressure.—Sunto della Lettura dell' Influenza Lunare sul Tempo tenuta da Giulio Grablovitz. The author, discussing the cloud observations made at Trieste from 1865 to 1882 inclusive, concludes that the moon exercises an influence on the extent of cloud which is invariable at a given place.—Rassegna Meteorico-agraria delle Osservazioni raccolte nella rete Meteorica Salentina nel 1883, del Dr. C. de Giorgi. This is a brief summary of meteorological observations made at a number of stations in the south of Italy during 1883.

Cape of Good Hope. Report of the Meteorological Commission for the Year 1883. Folio, 1884. 70 pp.

In addition to the usual information, this Report gives in the Appendix—(1) Tables of the average rainfall at stations where records have been kept for at least five years; (2) Table of mean monthly temperature at the Royal Observatory, Cape of Good Hope, 1871-1882; and (3) Notes on the disturbances to thermometer-readings from local causes, by A. Smith.

Ciel et Terre. Revue Populaire d'Astronomie, de Météorologie et de Physique du Globe. Vol. V., Nos. 11-16, August-October, 1884. 8vo.

The principal meteorological contents are:—Un hivernage au Spitzberg (11 pp.).—Recherches sur la nature et la cause des orages (7 pp.).—La variabilité des pluies en Belgique suivant la situation topographique (6 pp.).

Journal of the Scottish Meteorological Society. Third Series, No. 1. 4to. 1884.

This is the first number of a new series, which it is proposed should be published annually in March, instead of at irregular periods as formerly. In addition to the results of observations for the year 1883, and the Reports of the Council, this Number contains the following papers:—Meteorology of Ben Nevis (first report), by A. Buchan (24 pp.).—On the various suggestions as to the source of atmospheric electricity, by Prof. Tait (3 pp.).—Preliminary Reports on some observations made in connection with Scottish Fisheries during the summer of 1883 (7 pp.).—Preliminary work at the Scottish Marine Station, Granton, by J. T. Cunningham (1 p.).—Report on the work of the Scottish Marine Station for scientific research, by J. T. Cunningham (4 pp.).—Tidal variations in Temperature at the Scottish Marine Station, by H. R. Mill (3 pp.).

Philosophical Magazine. August 1884. 8vo.

Contains a preliminary notice of a new sunshine recorder by Dr. Herbert M'Leod, F.R.S. The apparatus consists of a camera so fixed that its axis is parallel to the polar axis of the earth, the lens pointing northwards. Opposite the lens a silvered sphere is placed. The rays from the sun are reflected from the sphere through the lens of the camera on to the sensitive paper on which a distorted image of the sun is formed, and the positions of the lens and sphere are so arranged that the image is a linear one and radial. By the motion of the earth the image is carried round in a circular arc, tracing a curve on the sensitive paper. Ten seconds of sunshine are sufficient to make an impression. One minute's cloudy interval will be represented by a light line appearing in the ring. The time scale is made by drawing from the centre of the circular band radial lines containing between them angles of 15° representing hours of time.

Proceedings of the Royal Society. Vol. XXXVII. No. 232. 8vo. 1884.

Contains:—On the connection of the Himalaya Snowfall with Dry Winds and Seasons of Drought in India, by H. F. Blanford, F.R.S. (18 pp.). The principal facts and conclusions set forth in this paper are:—1. The experience of recent years affords many instances of an unusually heavy and especially a late fall of snow on the North-western Himalaya being followed by a prolonged period of drought on the plains of North-western and Western India. 2. On tabulating the average rainfall of the winter and spring months at the stations of the North-western Himalaya, year by year, for the last eighteen years, and comparing it with the average rainfall of the North-western Provinces in the ensuing summer monsoon, it is found that with four exceptions an excessive winter precipitation on the hills is followed by a deficient summer rainfall on the plains, and *vice versâ*. Of the four apparent exceptions, two are found to afford a striking support to the first proposition. 3. The West winds which, in Western and Northern India, are characteristic of seasons of drought as abnormal winds, are identical in character with the normal winds of the dry season, and appear to be fed by descending currents from the North-western Himalaya and possibly the western mountains generally. 4. It is a common and well-known phenomenon of the winter months that a fall of rain and snow on the North-western Himalaya is immediately followed by a wave of high pressure advancing eastwards from the western mountains, accompanied with dry cool North-west winds. 5. The conclusion is that an unusual expanse of snow on the North-western Himalaya, whether due to the unmelted residue of an unusually copious winter snowfall, or to an unusually late fall in the spring months, acts, at high levels, in the summer months, in somewhat the same way as the ordinary falls of snow and rain on the Lower Himalaya do at low levels in the winter season, and favours the production of dry North-west winds on the plains of Western India. 6. That this dependence of dry winds on the Himalayan snow-fall affords a criterion for forecasting the probabilities of drought in North-western and Western India.

Proceedings of the Royal Society of Edinburgh. Session 1882-83. 8vo.

Contains:—Observations of the Rainband from June 1882 to January 1883, by H. R. Mill, B.Sc. (10 pp. and plate).—On the Moon and the Weather, by J. Aitken (3 pp.).

Results of Rain and River Observations made in New South Wales during 1883. H. C. Russell, B.A., F.R.A.S., Government Astronomer for New South Wales. 8vo. 1884. (27 pp. and 3 diagrams).

This system now comprises 385 stations. The tables give for each station and for each month the rainfall and number of days on which rain fell, together with the total for the year, and the average of all the records at each station. In addition to the usual rain map and diagram of rivers there is also a diagram showing the monthly distribution of the rain in each square degree of the Colony. The rainfall for 1883 was very deficient, the average of all the stations being only 17·96 ins. while the mean of the past nine years was 24·55 ins.

Symons's Monthly Meteorological Magazine. August-October 1884. 8vo.

The principal articles are:—The thunderstorms of July 1884 (14 pp.).—On the formation of air bubbles in water by drops of rain, by C. Tomlinson, F.R.S.

(3 pp.).—Meteorology at the International Health Exhibition (6 pp.).—The thunderstorms of August 1884 (6 pp.).—On the climate of the British Empire during 1883 (2 pp.).

THE PROCEEDINGS OF THE ROYAL SOCIETY OF QUEENSLAND, 1884. Vol. I. Part I. 8vo. 1884.

Contains :—Water supply: Springs and their origin, by J. Falconer (4 pp. and 6 plates).—On the Bowen Cyclone of 30th January, 1884, by J. Thorpe (5 pp. and plate).

THE QUARTERLY WEATHER REPORT, 1878. Appendices and Plates. Published by the authority of the Meteorological Council. Official No. 55. 4to. 1884.

Appendix II. contains a paper by Lt.-Gen. R. Strachey, F.R.S., "On the computation of the quantity of heat in excess of any fixed base temperature, received at any place during the course of the year, to supply a standard for comparison with the progress of vegetation" (20 pp.).

TRANSACTIONS OF THE HERTFORDSHIRE NATURAL HISTORY SOCIETY AND FIELD CLUB. Vol. II. Part 7 to Vol. III. Part 2. 8vo. 1883-4.

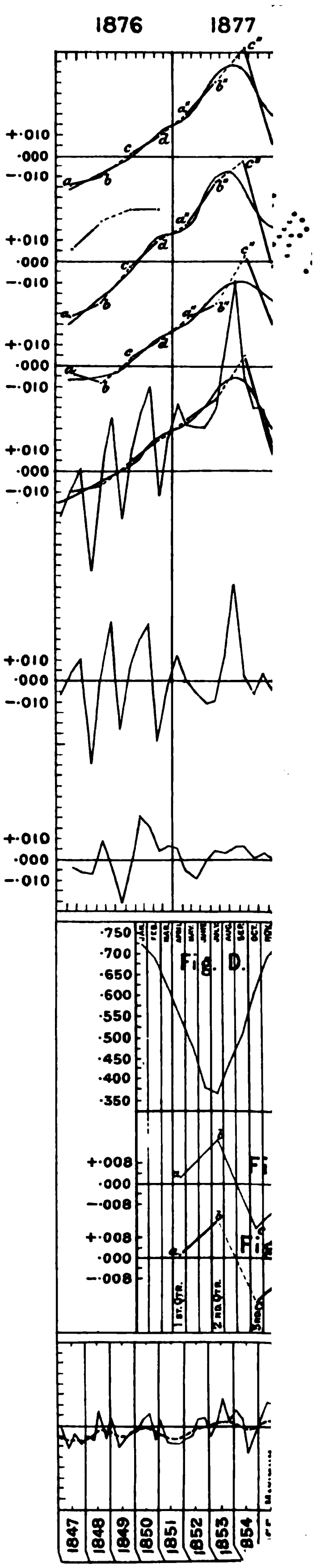
Contains :—Report on the Rainfall in Hertfordshire in 1882, by the Rev. C. W. Harvey (6 pp.).—Meteorological observations taken at Throcking, Herts, during the year 1882, by the Rev. C. W. Harvey (8 pp.).—Notes on Birds observed in Hertfordshire during the year 1883, by J. E. Littleboy (9 pp.).—Report on Insects observed in Hertfordshire during the year 1883, by F. W. Silvester (4 pp.).

ZEITSCHRIFT DER ÖSTERREICHISCHEN GESELLSCHAFT FÜR METEOROLOGIE. Redigirt von Dr. J. HANN. Band XIX. August-October 1884. 8vo.

The principal contents are:—Gewitterstudien in Italien, von Dr. C. Lang (19 pp.). This is an elaborate analysis of the publications of the Roman Central Meteorological Office on the subject of thunderstorms in 1877, 1878 and 1880. The materials are provided by the issue of post cards with a schedule for observations on the back. There were 570 observers in 1880, each representing nearly five square miles on the average, but they are very unevenly distributed.—Ueber kleine unregelmässige Schwankungen des Luftdruckes nach den Aufzeichnungen des Barographen, von A. Schönrock (4 pp.). This paper treats of the slight unevennesses in barograms, which the author finds to be frequently associated with thunderstorms, &c.—Bemerkungen über die Messungen der Sonnenwärme, von Dr. O. Frölich (3 pp.). This is a summary of a lecture to the Physical Society of Berlin, in which the author compares Langley's and Förster's results of the measurement of solar heat with those of his own.—Die Witterung auf dem Inselsberge im Jahre 1883 (3 pp.).—Ueber die Bestimmung der Temperatur und Feuchtigkeit der Luft, von H. Wild (12 pp.). This is a reply to Dr. Assmann's paper on the use of the *thermomètre fronde* as a hygrometer in the April No. of the *Zeitschrift*. Dr. Wild declares his own screen to be the only one which gives absolutely correct readings ; and the test which he applies is a severe one—that the indications of thermometers in such a screen are not affected more than 0°·1 C. by the introduction of artificial ventilation. He states that he has repeatedly proved that sling thermometers are affected by sunshine, and that their indications cannot be seriously considered as substitutes for ordinary readings, in fact this mode of observation should only be employed by travellers who are unable to procure a satisfactory exposure. The author concludes with a strong recommendation to apply mechanical ventilation to hygrometers.

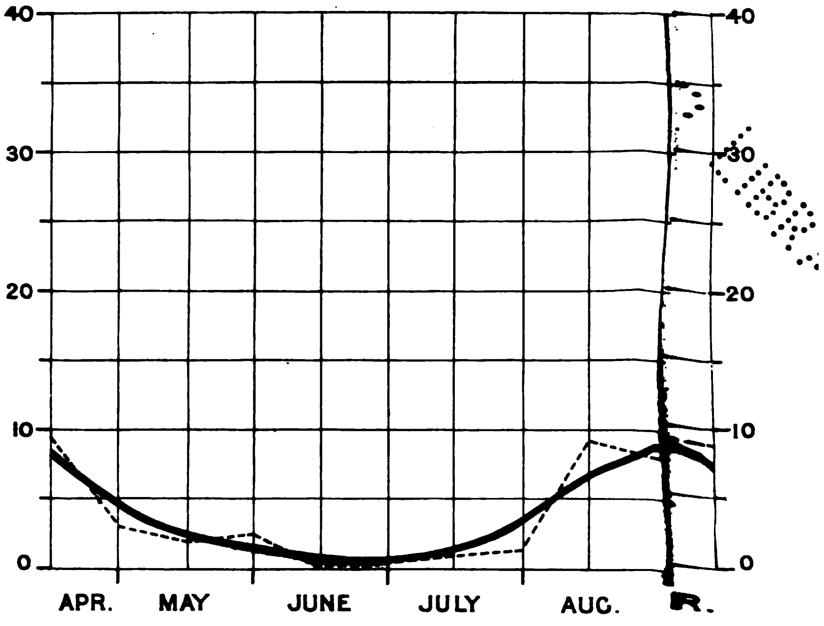
INDEX.

THE END.

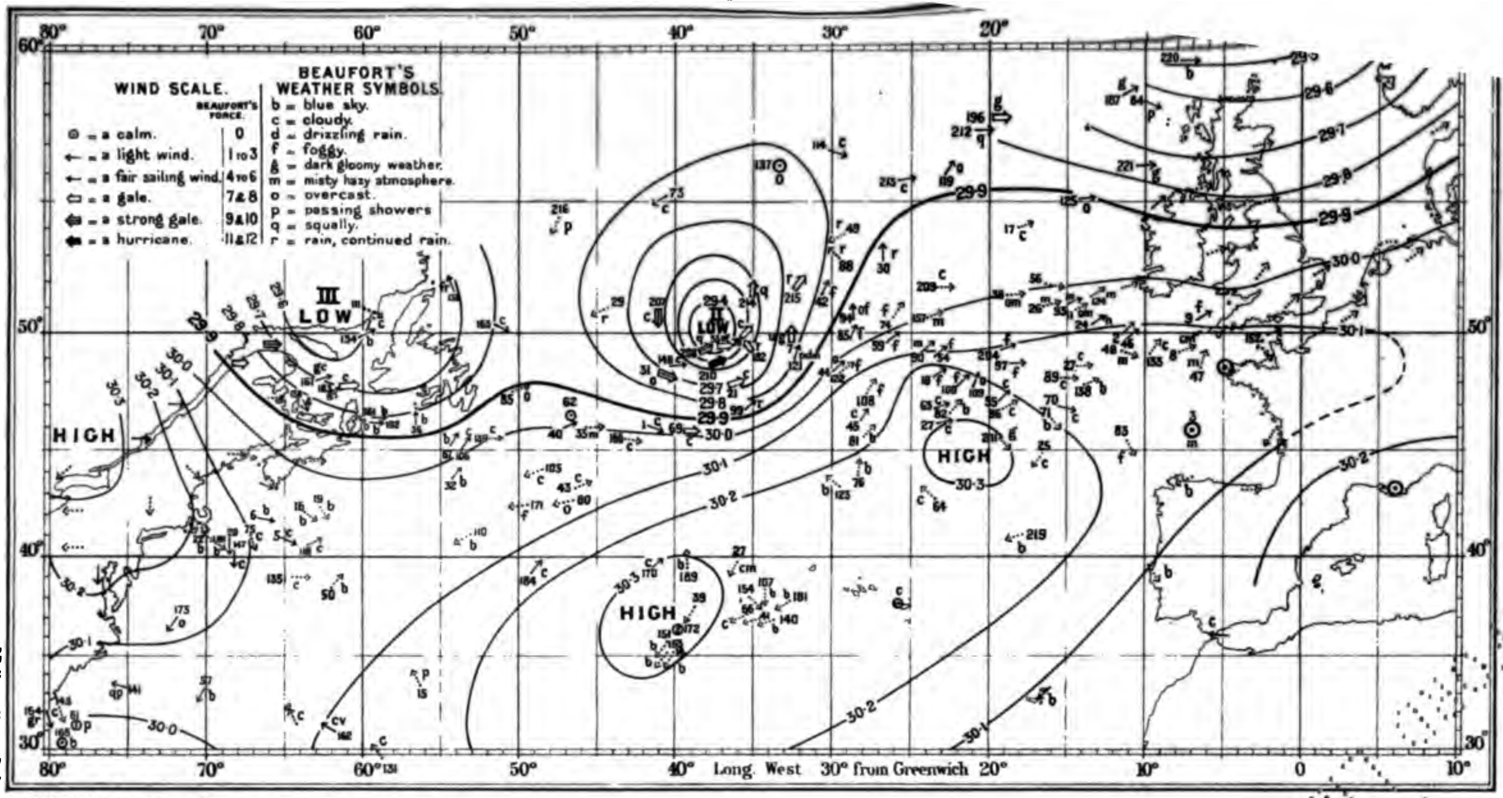

1876
1877
+·010
·000
−·010
·750
·700
·650
·600
·550
·500
·450
·400
·350
Fig. D.
+·008
·000
−·008
1 ST. QTR.
2 ND. QTR.
1847
1848
1849
1850
1851
1852
1853
1854

12.

DISTRI



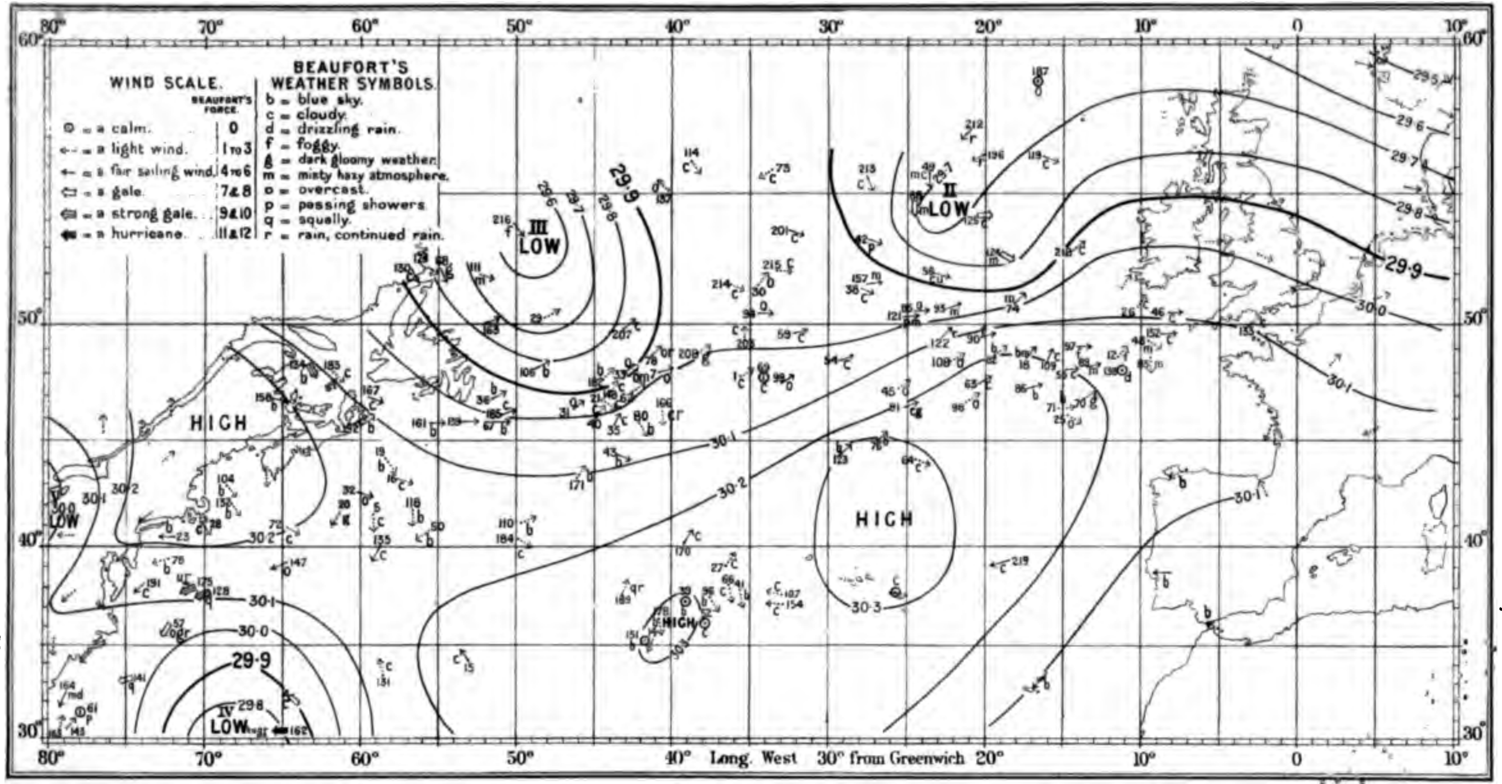
AUGUST 27th, 1883. —



Malby & Sons, Lith.

EXPLANATION.— The plain lines are isobars, for each tenth of an inch — — a broken line is used when an isobar is doubtful.
The arrows fly with the wind, the scale of force is given on each chart. The head of the arrow is at the position of observation.
... at the end of each arrow refer to the name of the vessel.
... arrows are the symbols of Beaufort's Weather Notation, the scale is given on each chart.
... centre of each depression, so that the progress can be traced from day to day.
... tember 1st and 3rd is numbered IV & V.

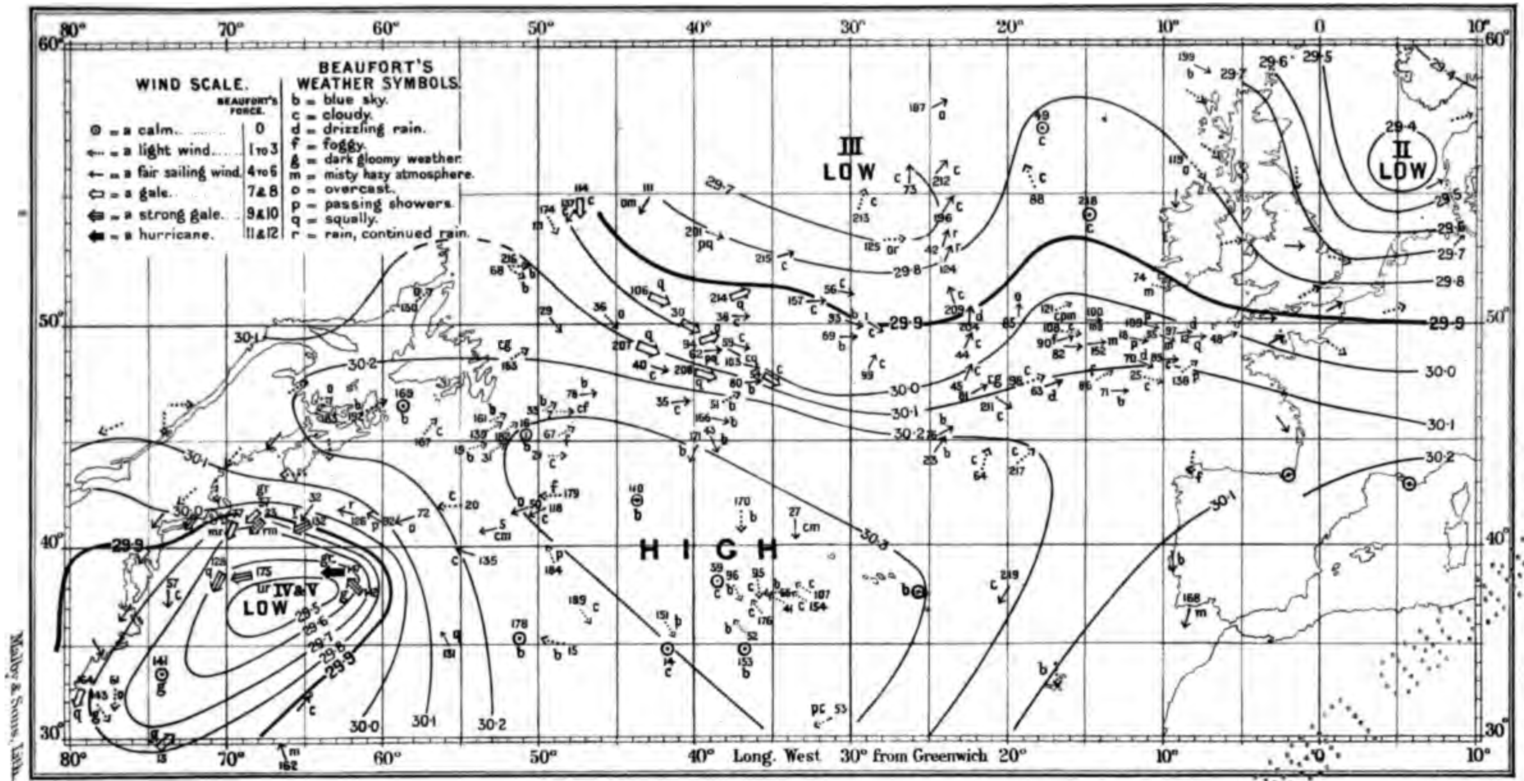
AUGUST 26th, 1883. 8 A.M. LOCAL TIME.



Malby & Sons, Lith.

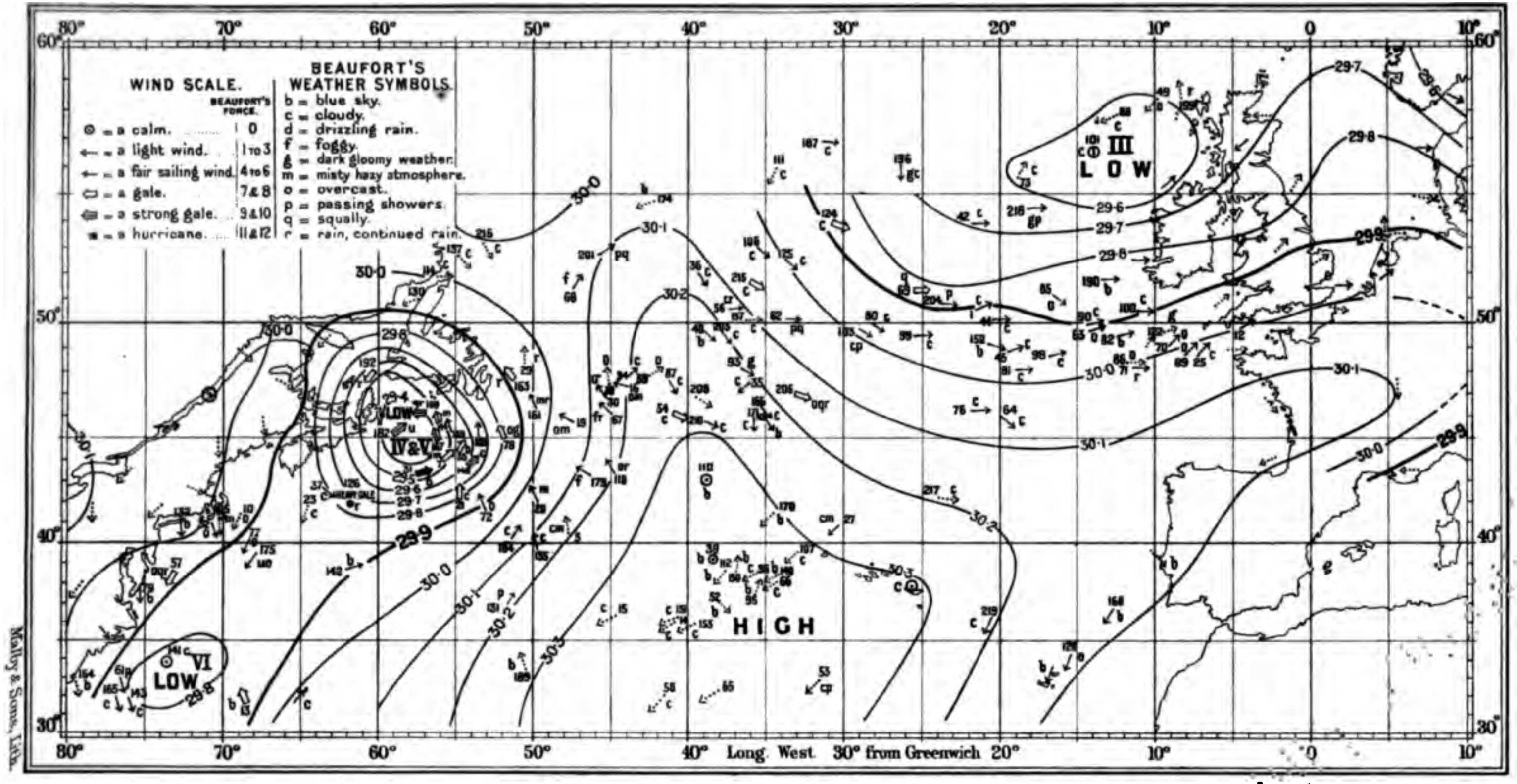
EXPLANATION.— The plain lines are isobars, for each tenth of an inch — a broken line is used when an isobar is doubtful.
The arrows fly with the wind, the scale of force is given on each chart. The head of the arrow is at the position of observation.
The figures at the end of each arrow refer to the name of the vessel.
The letters by the side of the arrows are the symbols of Beaufort's Weather Notation, the scale is given on each chart.
A number, in Roman figures, is given near the centre of each depression, so that the progress can be traced from day to day.
The storm which crossed the British Islands between September 1st and 3rd is numbered IV & V.

AUGUST 29TH, 1883. 8 A.M. LOCAL TIME.



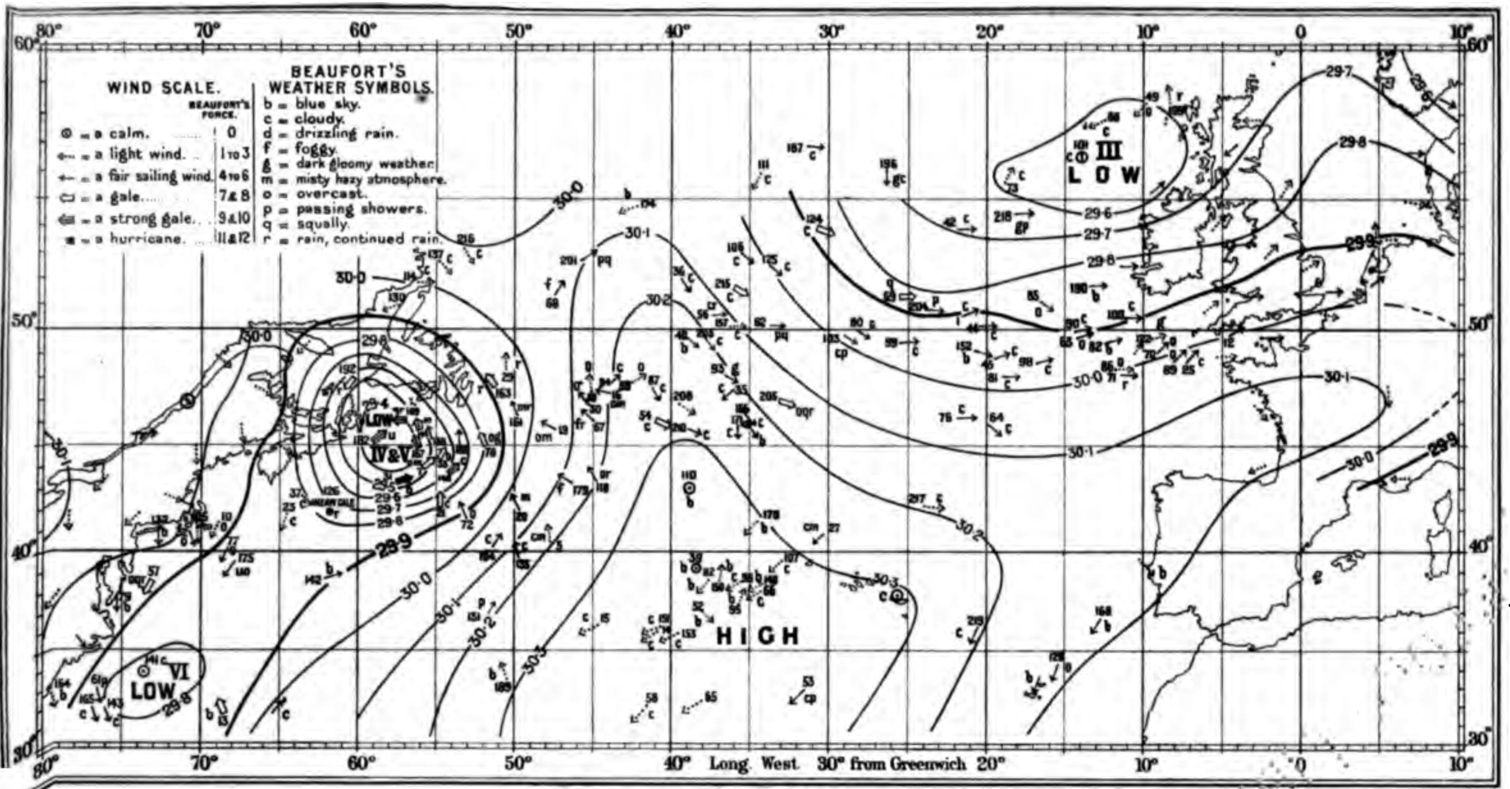
EXPLANATION.– The plain lines are isobars, for each tenth of an inch – – a broken line is used when an isobar is doubtful.
The arrows fly with the wind, the scale of force is given on each chart. The head of the arrow is at the position of observation.
The figures at the end of each arrow refer to the name of the vessel.
The letters by the side of the arrows are the symbols of Beaufort's Weather Notation, the scale is given on each chart.
A number, in Roman figures, is given near the centre of each depression, so that the progress can be traced from day to day.
The storm which crossed the British Islands between September 1st and 3rd is numbered IV & V.

Malby & Sons, Lith.

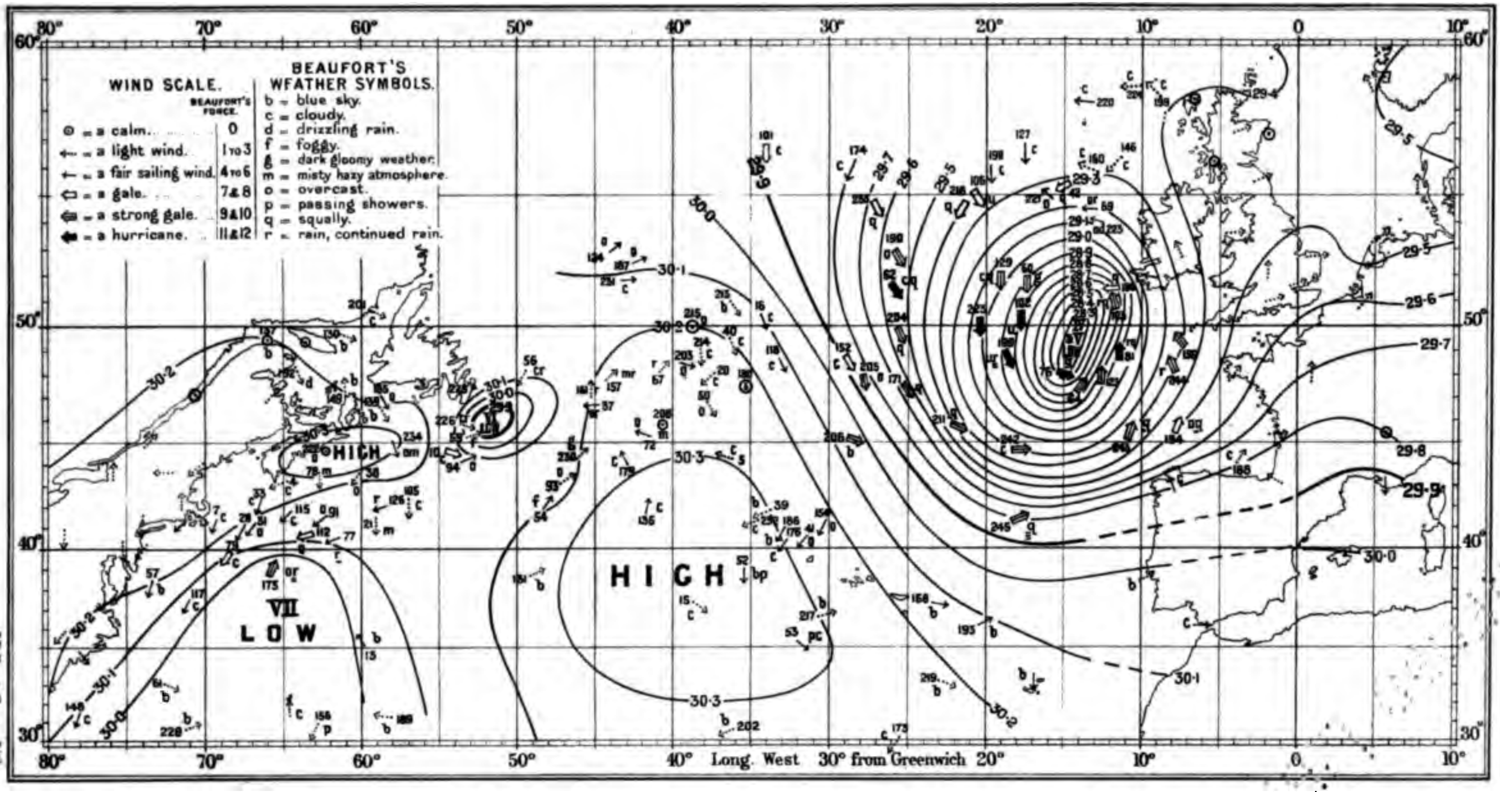


EXPLANATION.—The plain lines are isobars, for each tenth of an inch — — a broken line is used when an isobar is doubtful.
The arrows fly with the wind, the scale of force is given on each chart. The head of the arrow is at the position of observation.
The figures at the end of each arrow refer to the name of the vessel.
The letters by the side of the arrows are the symbols of Beaufort's Weather Notation, the scale is given on each chart.
A number, in Roman figures, is given near the centre of each depression, so that the progress can be traced from day to day.
The storm which crossed the British Islands between September 1st and 3rd is numbered IV & V.

AUGUST 30TH, 1883. — 8 A.M. LOCAL TIME.

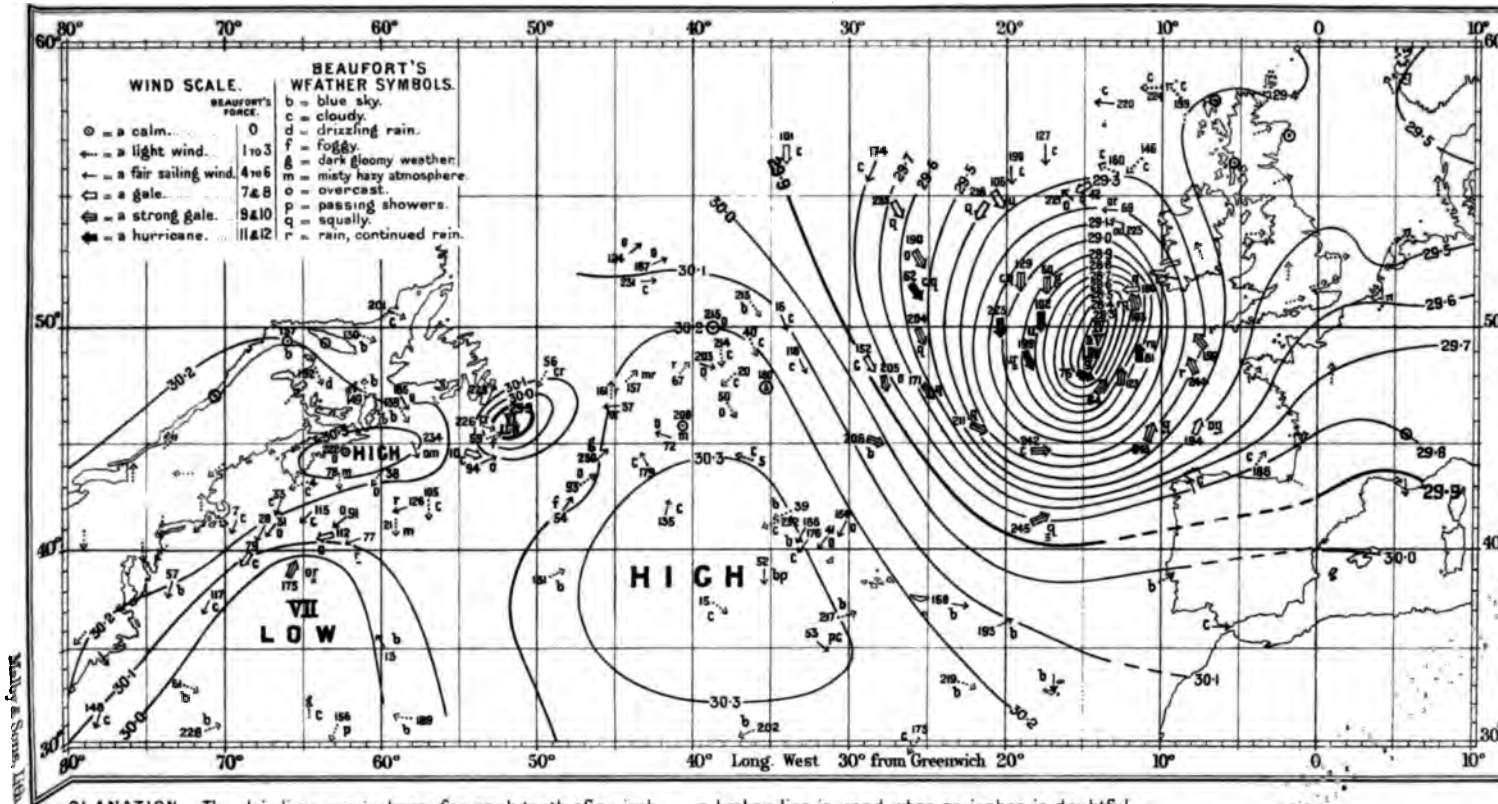


EXPLANATION.— The plain lines are isobars, for each tenth of an inch — — a broken line is used when an isobar is doubtful.
The arrows fly with the wind, the scale of force is given on each chart. The head of the arrow is at the position of observation.
The figures at the end of each arrow refer to the name of the vessel.
The letters by the side of the arrows are the symbols of Beaufort's Weather Notation, the scale is given on each chart.
A number, in Roman figures, is given near the centre of each depression, so that the progress can be traced from day to day.
The storm which crossed the British Islands between September 1st and 3rd is numbered IV & V.



Malby & Sons, Lith.

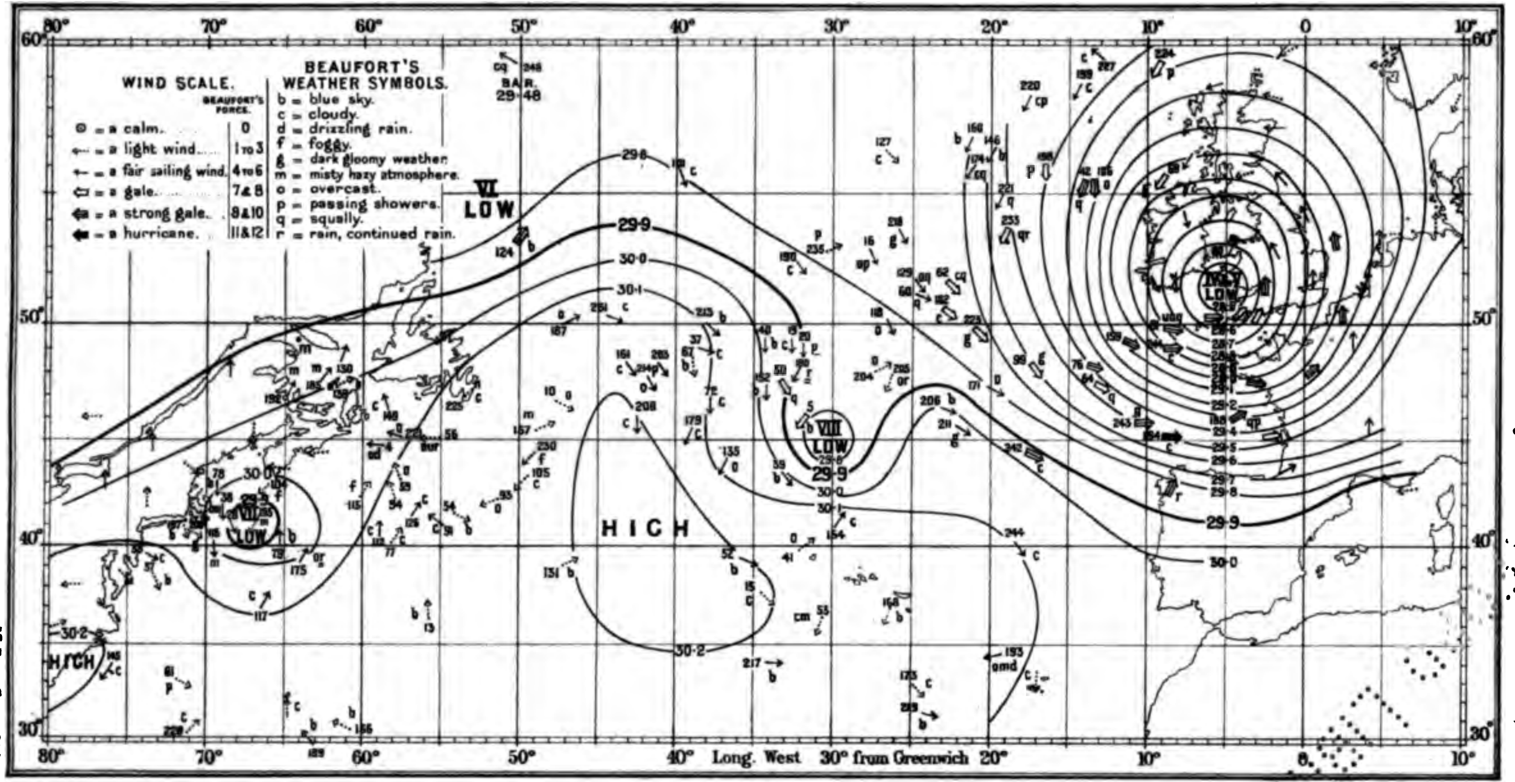
EXPLANATION.— The plain lines are isobars, for each tenth of an inch — — a broken line is used when an isobar is doubtful.
The arrows fly with the wind, the scale of force is given on each chart. The head of the arrow is at the position of observation.
The figures at the end of each arrow refer to the name of the vessel.
The letters by the side of the arrows are the symbols of Beaufort's Weather Notation, the scale is given on each chart.
A number, in Roman figures, is given near the centre of each depression, so that the progress can be traced from day to day.
The storm which crossed the British Islands between September 1st and 3rd is numbered IV & V.



Malby & Sons, Lith.

EXPLANATION.— The plain lines are isobars, for each tenth of an inch — — a broken line is used when an isobar is doubtful.
The arrows fly with the wind, the scale of force is given on each chart. The head of the arrow is at the position of observation.
The figures at the end of each arrow refer to the name of the vessel.
The letters by the side of the arrows are the symbols of Beaufort's Weather Notation, the scale is given on each chart.
A number, in Roman figures, is given near the centre of each depression, so that the progress can be traced from day to day.
The storm which crossed the British Islands between September 1st and 3rd is numbered IV & V.

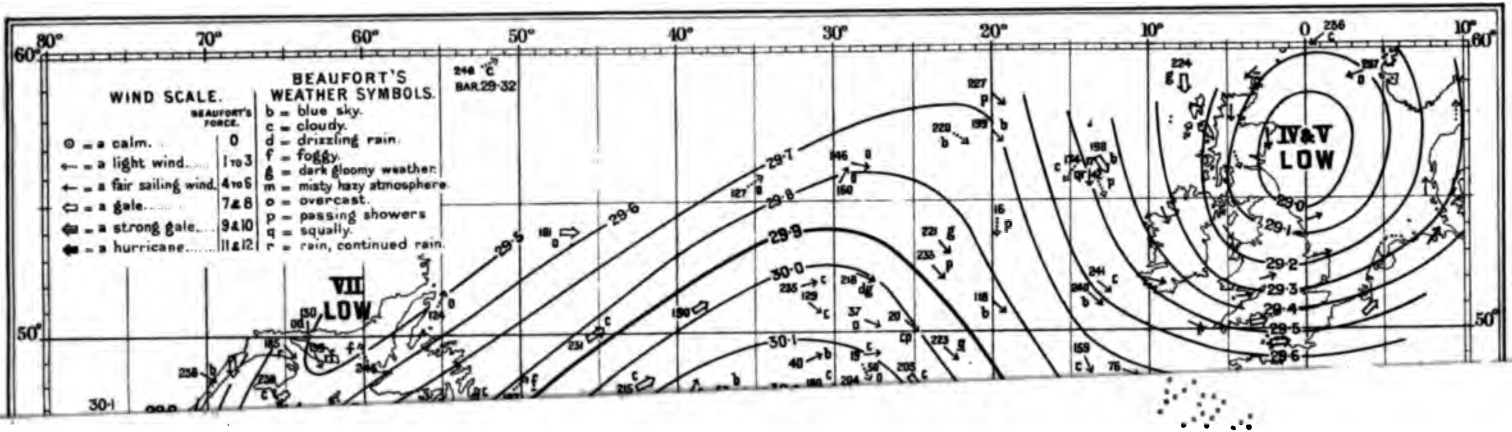
SEPTEMBER 2ND, 1883. — 8 A.M. LOCAL TIME.

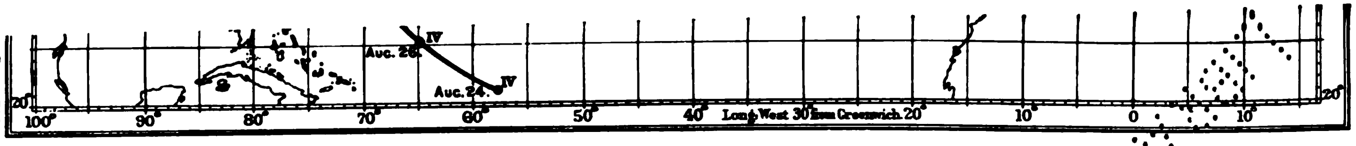


EXPLANATION.— The plain lines are isobars, for each tenth of an inch — — a broken line is used when an isobar is doubtful.
The arrows fly with the wind, the scale of force is given on each chart. The head of the arrow is at the position of observation.
The figures at the end of each arrow refer to the name of the vessel.
The letters by the side of the arrows are the symbols of Beaufort's Weather Notation, the scale is given on each chart.
A number, in Roman figures, is given near the centre of each depression, so that the progress can be traced from day to day.
The storm which crossed the British Islands between September 1st and 3rd is numbered IV & V.

Malby & Sons, Lith.

SEPTEMBER 3RD, 1883. — 8 A.M. LOCAL TIME.



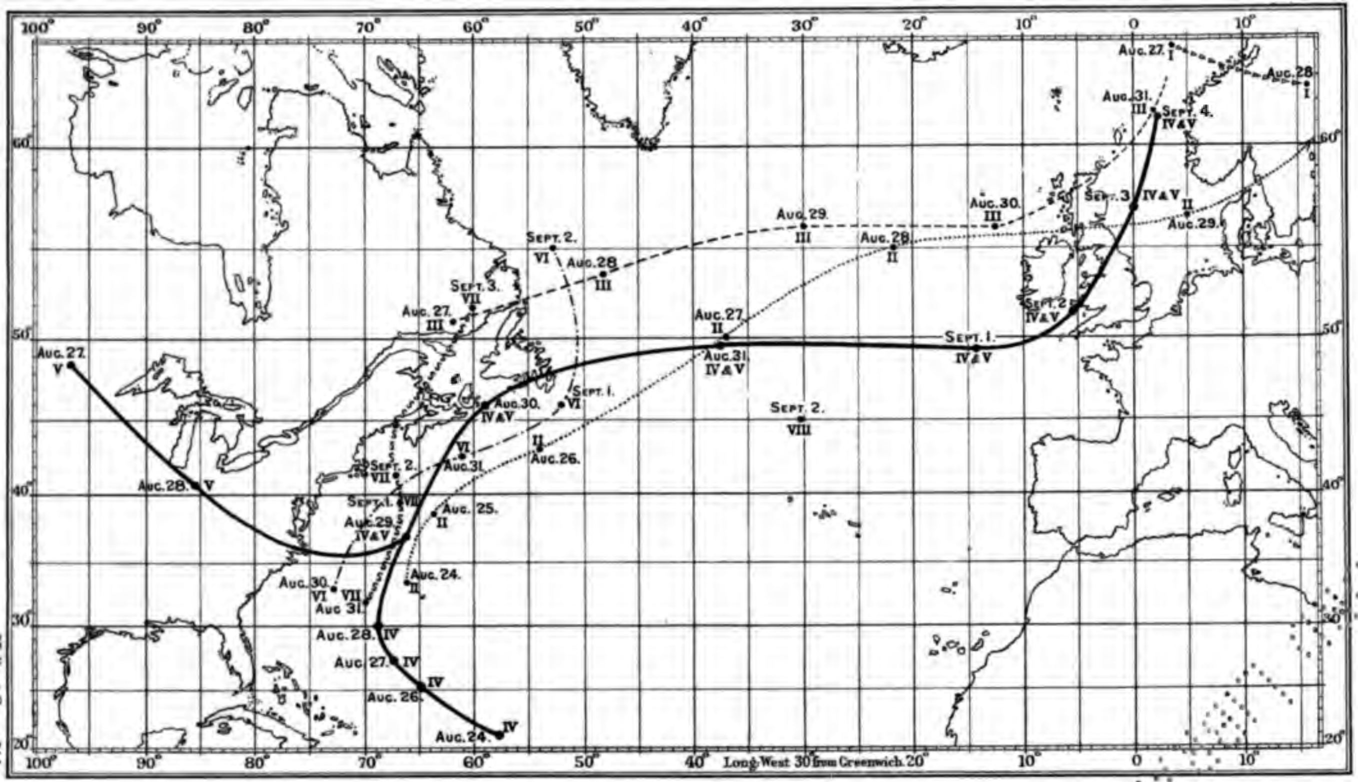


& Sons, Lith.

EXPLANATION.—The dots show the position of the storm-centres at 8 a.m. each day. The lines joining the dots show the tracks of the different storms.
The storm which crossed the British Islands between September 1st and 3rd is shown by a thick plain line.
The ordinary figures adjacent to the dots show the days of the month.
The Roman numerals .... Do. .... Do. .... give the numbers of the several storm-centres, they correspond with the numbers given on the charts for each day.

Quart. Journ. Roy. Met. Soc. Vol. X, Pl. 9.

TRACKS OF STORM-CENTRES AT END OF AUGUST AND BEGINNING OF SEPTEMBER, 1883.



Malby & Sons, Lith.

EXPLANATION.—The dots show the position of the storm-centres at 8 a.m. each day. The lines joining the dots show the tracks of the different storms.
The storm which crossed the British Islands between September 1st and 3rd is shown by a thick plain line.
The ordinary figures adjacent to the dots show the days of the month.
The Roman numerals .... Do. .... Do. .... give the numbers of the several storm-centres, they correspond with the numbers given on the charts for each day.

METEOROLOGY OF ENGLAND,

DURING THE QUARTER ENDING DECEMBER 31, 1883.

REMARKS ON THE WEATHER DURING THE QUARTER ENDING DECEMBER 31ST, 1883.

By JAMES GLAISHER, ESQ., F.R.S., *&c.*

The weather in October was cold during the first week and from the 18th to the 23rd, and mild at other times, particularly so during the last week of the month. The atmospheric pressure was above its average from the 5th to the 13th, and from the 26th, and was below at other times. The sky was mostly cloudy, with but little sunshine; the fall of rain was less than its average at most stations; there were no thunder storms at stations south of Bolton; and there were two or three at northern stations. Fog was prevalent on seven or eight days at stations in the Midland Counties. Snow fell at Halifax on five days.

The weather in November was mostly cold till the 15th, and warm from the 16th to the end of the month. The pressure of the atmosphere was generally below its average from the 4th to the 26th, particularly so on the 6th and 25th. The sky was generally clouded; there were a few bright days only. Rain fell very frequently, and generally in excess of the average. A little snow fell at different places north of latitude 51°, and fog was prevalent at some places on eight or nine days in the month. Thunder storms occurred at several stations south of 51½°, and at stations north of 54°.

The weather in December was variable till the 18th day, the temperature being for a few days together in excess of the average, and then for a few days in defect; from the 19th day to the end of the month the weather was unusually mild. The pressure of the atmosphere was variable, being alternately above and below till the 22nd, and constantly in excess from the 23rd day. The fall of rain was a good deal below the average at nearly every station. Snow fell at a few stations during the first half of the month. There was scarcely any fog till the 15th, and from this day till the end of the month it was unusually prevalent, particularly in the S.E. of England, where fog, frequently very dense, and cloudy dull skies were all but constant. The sun was scarcely visible during the last week of the year. During the greater part of this month, whenever the sky was clear, there was a peculiar glow of light visible both before sunrise and after sunset, and at times even through the clouds.

About London till the 7th of October the average daily deficiency was 5°·6; the weather was warmer from the 8th to the 17th, the mean daily excess being 2°·0. The six days, October 18th to 23rd, were cold, being in defect of their mean average temperature by 2°·3, there were then nine days of warm weather, the daily excess being 5°·2. From November 2nd to the 17th the days were cold, the average daily deficiency of mean temperature being 1°·7; this was followed by a like period of 16 days of warm weather, the daily excess being 3°·0; then for six days, from November 18th to December 3rd, the weather was cold, particularly on the 6th of December, on which day it was 9°·3 below the average, the mean daily deficiency of these six days was 6°·1; this was followed by five warm days, the average daily excess being 4°·6, then four days of cold, the deficiency being 2°·8 daily; from the 19th to the end of the year it was warm, and for these 13 days, ending December 31st, the excess was 2°·3 daily.

The mean temperature of the air for October was 50°·4, being 0°·9 and 0°·4 above the averages of 112 years and 42 years respectively; it was 0°·4 lower than in 1882, 5°·1 higher than in 1881, and 4°·2 higher than in 1880.

The mean temperature for November was 43°·8, being 1°·5 and 0°·3 above the averages of 112 years and 42 years respectively; it was 0°·3 higher than in 1882, 4°·9 lower than in 1881, and 1°·3 higher than in 1880.

The mean temperature for December was 40°·5, being 1°·4 and 0°·6 above the averages of 112 years and 42 years respectively; it was 0°·4 and 0°·7, respectively, above 1882 and 1881, and 2°·7 lower than in 1880.

The mean temperature for the quarter was 44°·9, being 1°·3 and 0°·4 above the averages of 112 years and 42 years respectively.

The mean high day temperatures for the air in October was 57°·1, being 1°·0 lower than the average of 42 years; in November it was 49°·6, being 0°·7 higher than the average, and in December was 44°·1, being 0°·6 lower than the average.

The mean low night temperature of the air in October was 44°·5, being 1°·0 higher than the average of 42 years; in November it was 37°·8, being 0°·5 higher than the average; and in December was 36°·2, being 1°·0 higher than the average.

Therefore, the high day temperature was cold during the day in October, and warm at night, in November being warm both day and night, and in December the days were cold and the nights warm.

The mean daily range of temperature in October was 2°·0 smaller than the average, in November it was 0°·3 greater than the average, and in December it was 1°·4 smaller than the average.

The mean temperature of the air in October was 6°·4 lower than in September; in November it was 6°·6 lower than in October, and in December it was 3°·3 lower than in November.

(From the preceding 42 years' observations the decrease of temperature from September to October, is 7°·1; the decrease of temperature from October to November is 6°·5, and the decrease from November to December is 3°·6.)

From September to October there was a decrease of temperature at stations south of 51° of 5°·5, between 51° and 52° of 6°·1, between 52° and 53° of 6°·2, between 53° and 54° of 6°·6, and between 54° and 55° of 7°·1.

From October to November there was decrease of temperature at stations south of 51° of 5°·2, between 51° and 52° of 6°·6, between 52° and 53° of 7°·4, between 53° and 54° of 6°·0, and between 54° and 55° of 6°·0.

From November to December there was a decrease of temperature at stations south of 51° of 3°·4, between 51° and 52° of 2°·9, between 52° and 53° of 2°·1, between 53° and 54° of 1°·7, and between 54° and 55° of 1°·4.

1883. Months.	Temperature of Air. Mean.	Air. Diff. from average of 112 years.	Air. Diff. from average of 42 years.	Evaporation. Mean.	Evaporation. Diff. from average of 42 years.	Dew Point. Mean.	Dew Point. Diff. from average of 42 years.	Air—Daily Range. Mean.	Air—Daily Range. Diff. from average of 42 years.	Elastic Force of Vapour. Mean.	Elastic Force of Vapour. Diff. from average of 42 years.	Weight of Vapour in a Cubic Foot of Air. Mean.	Weight of Vapour. Diff. from average of 42 years.
	°	°	°	°	°	°	°	°	°	in.	in.	grs.	gr.
Oct. -	50·4	+0·9	+0·4	48·4	+0·5	46·2	+0·3	12·6	−2·6	0·313	+0·002	3·6	−0·2
Nov. -	43·8	+1·5	+0·3	41·9	+0·5	39·8	+0·4	11·8	+0·3	0·245	−0·002	2·8	−0·1
Dec. -	40·5	+1·4	+0·6	38·7	+0·2	36·3	−0·3	8·0	−1·4	0·214	−0·004	2·5	−0·1
Means -	44·9	+1·3	+0·4	43·0	+0·4	40·8	+0·1	10·8	−1·0	0·257	−0·001	3·0	−0·1

1883. Months.	Degree of Humidity. Mean.	Humidity. Diff. from average of 42 years.	Reading of Barometer. Mean.	Barometer. Diff. from average of 42 years.	Weight of a Cubic Foot of Air. Mean.	Weight. Diff. from average of 42 years.	Rain. Amount.	Rain. Diff. from average of 67 years.	Daily Horizontal movement of the Air.	Reading of Thermometer on Grass. Number of Nights it was At or below 30°.	Between 30° and 40°.	Above 40°.	Lowest Reading at Night.	Highest Reading at Night.
			in.	in.	grs.	grs.	in.	in.	Miles.				°	°
Oct. -	86	0	29·800	+0·022	541	+ 1	1·59	−1·25	294	1	22	8	29·6	50·1
Nov. -	86	− 2	29·659	−0·081	546	− 1	2·84	+0·50	322	6	19	5	23·7	44·8
Dec. -	85	− 4	29·983	+0·195	555	+ 4	0·83	−1·18	369	5	26	0	24·7	38·9
Means -	86	− 2	29·814	+0·008	547	+ 1	Sum 5·26	Sum −1·93	Mean 328	Sum 12	Sum 67	Sum 13	Lowest 23·7	Highest 50·1

Note.—In reading this table it will be borne in mind that the plus sign (+) signifies *above* the average, and that the minus sign (−) signifies *below* the average.

Average duration of the different directions of the wind referred to eight points of the compass, and duration of each direction in each month in the quarter, were as follows:—

Direction of Wind.	October. 1883.	October. Average.	October. Departure from Average.	November. 1883.	November. Average.	November. Departure from Average.	December. 1883.	December. Average.	December. Departure from Average.
	d.	d.	d.	d.	d.	d.	d.	d.	d.
N.W.	3	2½	+ ½	5	2½	+2½	11¼	2½	+8¾
N.	3	3½	− ½	½	4½	−4	2	3	−1
N.E.	1	3	− 2	0	4	−4	3	2½	+ ½
E.	4	1½	+ 2½	2¼	2¼	0	2	2	0
S.E.	2	2	0	1½	2	− ½	½	2	−1½
S.	2	4	− 2	2	4	−2	1½	3½	−2
S.W.	7	10	− 3	10½	8½	+2	6	11	−5
W.	9	4½	+ 4½	8½	2½	+6	4¾	4½	+ ¼

The plus sign (+) denotes excesses over averages; the largest numbers affected with this sign in the month of October are opposite to W. and E.; in November to W. and N.W.; and in December to N.W. and N.E.

The minus sign (−) denotes deficiencies below averages. In October the largest numbers are opposite to S.W., N.E., and S.; in November to N., N.E., and S.; and in December to S.W. and S.

About London the mean daily pressure of the atmosphere till October 4th was below the average by 0·11 in. daily, from the 5th to the 13th it was above by 0·32 in. daily, then for 12 days it was below by 0·10 in. daily; from October 26th to November 3rd, it was above by 0·28 in. daily. A period of 9 days of low readings followed, viz., from November 4th to the 12th, the mean amount for the 9 days being 0·32 in.; from the 13th to the 15th, the barometer readings were above their averages by 0·13 in., and on the 16th and 17th, they were 0·16 in. too low; from the 18th to the 21st, the pressure was in excess averaging 0·08 in.; for 5 days it was below by 0·37 in.; the reading on November 25th, was 28·901 ins., being the lowest mean daily reading

in the quarter; from November 27th to December 2nd, it was above by 0·33 in. daily, for 2 days it was 0·13 in. too low; from December 5th to 9th, it was daily 0·36 in. too high; from December 10th to 16th, it was 0·22 in. below the average; and from December 17th to the end of the year it was high, the average daily excess being 0·30 in. The highest mean daily reading in the quarter was 30·395 ins. on December 25th.

The mean reading of the barometer for the month of October at the height of 160 feet above the level of the sea was 29·800 ins., being 0·092 in. above the average of 42 years; 0·144 in. higher than that in 1882, 0·027 in. lower than in 1881; and 0·095 in. higher than in 1880.

The mean reading of the barometer for the month of November was 29·659 ins., being 0·084 in. below the average of 42 years; 0·127 in. higher than in 1882, 0·126 in. lower than in 1881, and 0·134 in. lower than in 1880.

The mean reading of the barometer for the month of December was 29·983 ins., being 0·195 in. above the average of 42 years, 0·490 in. higher than in 1882, 0·162 in. higher than in 1881; and 0·234 in. higher than in 1880.

From September to October there was an increase of pressure at stations south of 51° of 0·158 in.; between 51° and 52° of 0·153 in.; between 52° and 53° of 0·144 in.; between 53° and 54° of 0·123 in. and north of 54° of 0·103 in.

From October to November there was a decrease of pressure at stations south of 51° of 0·130 in.; between 51° and 52° of 0·156 in., between 52° and 53° of 0·156 in., between 53° and 54° of 0·172 in., and north of 54° of 0·210 in.

From November to December there was an increase of pressure at stations south of 51° of 0·363 in., between 51° and 52° of 0·350 in., between 52° and 53° of 0·336 in., between 53° and 54° of 0·376 in., and north of 54° of 0·406 in.

Thunderstorms occurred in October on the 3rd at Llandudno, Bolton, and Stonyhurst; on the 17th at Stonyhurst; on the 18th at Bolton, Halifax, and Stonyhurst, and on the 24th at Silloth.

In November, on the 9th at Stonyhurst and Silloth; on the 10th at Guernsey; on the 17th at Osborne, Salisbury, and Bath; on the 20th at Bath and Halifax; on the 22nd at Carlisle; on the 24th at Torquay; and on the 25th at Plymouth, Torquay, Ventnor, and Osborne.

In December, on the 4th at Somerleyton; on the 10th at Halifax, and on the 11th at Bolton and Hull.

Thunder was heard but lightning was not seen in October, on the 3rd at Burslem and Bolton; on the 16th at Llandudno and Halifax; on the 17th at Llandudno; on the 18th at Lancaster. In November, on the 7th at Osborne; on the 17th at Whitchurch; on the 24th at Rugby, and on the 25th at Whitchurch.

Lightning was seen but thunder was not heard in October, on the 3rd at Torquay, Oxford, Wolverhampton, and Halifax; on the 19th at Carlisle; on the 20th at Osborne and Stonyhurst, and on the 21st at Oxford.

In November, on the 20th at Carlisle; on the 22nd at Llandudno and Stonyhurst, and on the 25th at Guernsey, Torquay, Whitchurch, Oxford, and Rugby.

In December, on the 3rd at Blackheath, Oxford, Lowestoft, Wolverhampton, and Hull; and on the 6th at Oxford.

Solar halos were seen in October, on the 2nd at Torquay and Oxford; on the 5th and 10th at Torquay; on the 11th at Stonyhurst; on the 12th and 13th at Halifax; and on the 22nd and 23rd at Torquay.

In November, on the 5th at Torquay and Oxford; on the 6th at Torquay; on the 7th, 10th, and 11th at Oxford; on the 21st at Guernsey; on the 23rd at Torquay and Oxford; on the 24th at Torquay, and on the 25th and 29th at Oxford.

In December, on the 2nd at Halifax; on the 12th at Barnet and Oxford; and on the 23rd at Oxford.

Lunar halos were seen in October, on the 11th at Torquay and Silloth; on the 15th at Cambridge; on the 16th at Torquay and Blackheath; and on the 18th at Cambridge.

In November, on the 7th at Torquay; on the 11th at Burslem and Royston; and on the 17th at Torquay and Bolton.

In December, on the 7th at Blackheath; on the 11th at Oxford and Cambridge; and on the 12th at Blackheath.

Aurora borealis was seen in October, on the 5th at Cambridge, Stonyhurst, Carlisle, and Silloth.

In November, on the 22nd at Llandudno and Silloth; and on the 28th at Blackheath.

In December, on the 1st at Torquay; and on the 2nd at Torquay and Whitchurch.

Snow fell in October, on the 1st at Cambridge; on the 3rd, 17th, 18th, 19th, and 20th at Halifax.

In November, on the 10th at Burslem and Bradford; on the 14th at Royston and Bradford; on the 15th at Bolton; on the 17th at Rugby; on the 19th at Burslem; on the 20th at Silloth; and on the 23rd at Marlborough.

In December, on the 4th at Somerleyton and Hull; on the 5th at Bolton and Hull; on the 6th at Guernsey, Torquay, Ventnor, Osborne, Southbourne, Strathfield Turgiss, Bath, Marlborough, Whitchurch, Blackheath, Barnet, Oxford, Burslem, Royston, Cardington, Cambridge, Rugby, Wolverhampton, Bolton, Halifax, Silloth and Carlisle; on the 7th at Guernsey; on the 11th at Bolton; on the 14th at Halifax; on the 15th at Bolton, Halifax, and Silloth; on the 16th at Strathfield Turgiss and Rugby; on the 17th at Marlborough, Royston, Cardington, Cambridge, and Hull; and on the 18th at Barnet and Rugby.

MONTHLY METEOROLOGICAL TABLE FOR THE QUARTER ENDING DECEMBER 31st, 1883.

The Observations have been reduced to Mean values by Glaisher's Barometrical and Diurnal Range Tables, and the Hygrometrical results have been deduced from the sixth edition of his Hygrometrical Tables.

Names of Stations and Observers.	Height of Station above Sea Level.	Year 1883. Months.	Pressure of Atmosphere in Month. Mean.	Pressure of Atmosphere in Month. Range.	Temperature of Air in Month. Highest.	Lowest.	Range.	Mean Of all Highest.	Mean Of all Lowest.	Mean Daily Range.	Mean Temperature. Air.	Mean Temperature. Dew Point.	Vapour. Elastic Force.	Vapour. In a cubic foot of Air. Mean.	Vapour. In a cubic foot of Air. Short of Saturation.	Mean Degree of Humidity. Satn. = 100.	Mean Weight of a cubic foot of Air.	Mean Reading of Thermometer. Maximum in Rays of Sun.	Mean Reading of Thermometer. Minimum on Grass.	Wind. Estimated Strength.	Wind. Relative Proportion of N.	E.	S.	W.	Mean Amount of Ozone.	Mean Amount of Cloud.	Rain. Number of Days it fell.	Rain. Amount collected.
	feet.		in.	in.	°	°	°	°	°	°	°	°	in.	grs.	gr.		grs.	°	°									
GUERNSEY, ADOLPHUS COLLENETTE, Esq., F. R. Met. Soc.	270	Oct.	29·741	0·985	62·0	42·0	20·0	57·3	48·6	8·7	52·4	47·6	·330	3·7	0·7	84	537	105·4	42·9	1·2	7	7	6	11	3·4	6·8	18	3·53
		Nov.	29·617	1·236	58·0	37·4	20·6	52·8	44·0	8·8	47·9	42·8	·274	3·1	0·6	85	531	79·7	39·8	1·3	5	3	8	14	3·2	7·0	24	6·52
		Dec.	29·958	0·869	53·6	31·0	22·6	47·3	41·6	5·7	44·3	39·6	·252	2·8	0·5	85	551	65·5	38·9	1·1	9	6	5	11	3·1	8·4	19	1·35
TRURO (Cornwall), C. BARHAM, Esq., M.D., F. R. Met. Soc.	43	Oct.	29·917	1·140	64·0	31·0	33·0	58·8	47·5	11·3	52·1	43·5	·329	3·6	0·7	84	541	—	—	2·4	5	7	7	12	—	6·9	16	3·67
		Nov.	29·798	1·223	58·0	26·0	32·0	54·2	41·9	12·3	47·2	42·6	·273	3·3	0·4	85	544	—	—	2·2	5	5	7	13	—	7·0	21	6·15
		Dec.	30·195	0·770	55·0	26·0	29·0	49·8	40·2	9·6	44·9	40·5	·247	2·8	0·5	85	551	—	—	2·1	9	8	5	9	—	7·8	18	1·74
PLYMOUTH (Devon), J. MERRIFIELD, Esq., LL.D., F.R.A.S., F. R. Met. Soc.	69	Oct.	29·933	1·152	62·0	33·5	28·5	57·7	45·5	12·2	51·1	47·0	·325	3·6	0·6	86	542	—	—	1·4	9	5	7	10	—	6·4	18	3·12
		Nov.	29·115	1·255	56·1	32·5	23·6	52·4	39·8	12·7	46·0	43·1	·280	3·2	0·6	91	546	—	—	1·6	5	5	4	16	—	6·8	24	4·47
		Dec.	30·202	0·916	54·0	28·0	26·0	48·0	38·9	9·1	43·5	40·0	·248	2·9	0·4	87	556	—	—	1·3	9	6	2	14	—	7·6	18	0·88
TOTNES (Devon), T. H. EDMONDS, Esq.	107	Oct.	29·931	1·142	65·3	30·9	34·4	58·5	43·6	14·9	50·9	46·2	·314	3·6	0·6	85	543	—	—	2·2	5	7	8	11	—	7·0	19	4·40
		Nov.	29·800	1·404	58·5	24·4	34·1	52·4	38·7	13·7	45·7	41·3	·265	3·0	0·5	87	546	—	—	2·8	5	2	9	14	—	6·5	23	5·96
		Dec.	30·164	1·024	54·5	21·7	32·8	47·4	37·0	10·4	42·7	37·6	·226	2·6	0·6	83	557	—	—	2·1	6	6	2	17	—	6·6	19	1·82
TORQUAY, Babbacombe (Devon), EDWIN E. GLYDE, Esq., F. R. Met. Soc.	305	Oct.	29·682	1·208	64·2	36·1	28·1	57·3	45·9	11·4	51·2	46·4	·314	3·6	0·7	84	538	96·2	38·0	1·4	8	5	8	10	5·0	7·2	17	3·03
		Nov.	29·536	1·357	57·0	28·1	28·9	51·9	40·4	11·5	46·2	42·8	·276	3·2	0·5	85	541	89·2	32·6	1·6	4	3	9	14	4·9	6·6	24	4·54
		Dec.	29·903	1·013	54·0	30·0	24·0	46·9	38·7	8·2	42·8	38·2	·231	2·7	0·6	84	551	71·5	31·8	1·6	8	3	5	15	3·9	7·2	13	0·65
VENTNOR, (Isle of Wight) (Royal National Hospital for Consumption), HARTLEY SAGAR, Esq.	80	Oct.	29·890	1·079	64·4	40·5	23·9	58·4	48·8	9·6	52·8	48·4	·346	3·8	0·6	85	540	—	—	1·2	6	8	6	11	6·5	6·4	16	2·84
		Nov.	29·752	1·336	58·6	33·9	24·7	53·0	43·1	9·9	47·6	42·1	·268	3·3	0·7	82	543	—	—	1·0	6	4	4	16	6·3	6·5	19	5·14
		Dec.	30·078	0·866	53·2	29·3	23·9	46·5	38·7	7·8	42·6	38·9	·237	2·7	0·4	87	555	—	—	1·3	12	5	3	11	6·1	7·8	11	1·23
OSBORNE (Isle of Wight), J. R. MANN, Esq.	172	Oct.	29·811	1·072	64·0	37·1	26·9	58·4	45·6	12·8	51·1	48·1	·337	3·8	0·4	89	540	91·8	44·5	0·8	8	4	8	11	—	5·9	13	2·57
		Nov.	29·681	1·304	56·3	29·1	27·2	51·2	38·5	12·7	44·8	41·3	·263	2·9	0·5	87	545	78·3	37·4	0·1	5	2	8	15	—	6·4	19	4·38
		Dec.	30·015	0·838	52·4	27·0	25·4	45·0	36·6	8·4	41·0	38·5	·233	2·7	0·3	91	555	59·4	35·5	0·1	7	5	5	14	—	7·4	14	0·90
BRIGHTON, F. E. SAWYER, Esq., F. R. Met. Soc.	206	Oct.	29·771	1·069	61·0	37·0	24·0	56·5	45·3	11·2	50·6	45·5	·305	3·5	0·7	82	540	—	40·5	1·2	9	6	6	10	—	5·9	15	2·57
		Nov.	29·632	1·356	58·5	31·1	27·4	47·1	39·4	7·7	42·9	39·6	·240	2·8	0·4	88	546	—	33·5	1·3	6	4	5	15	—	5·7	21	3·75
		Dec.	29·950	0·965	52·0	26·0	26·0	44·9	35·5	9·4	40·5	36·4	·215	2·6	0·5	86	555	—	34·5	1·0	11	5	5	10	—	6·9	16	1·26
SOUTHBOURNE, (near) Bournemouth (Hants), T. A. COMPTON, Esq., M.D., B.A., F. R. Met. Soc.	95	Oct.	29·883	1·114	62·1	35·5	26·6	57·2	45·8	11·4	51·0	45·7	·309	3·5	0·4	82	542	—	—	1·1	11	4	4	12	—	5·6	14	2·13
		Nov.	29·747	1·306	57·8	24·8	31·0	51·4	39·7	11·7	45·7	41·2	·260	2·9	0·5	85	545	—	—	1·2	8	2	6	14	—	5·3	17	3·68
		Dec.	30·114	0·820	55·0	23·2	31·8	45·9	37·3	8·6	41·7	37·0	·221	2·5	0·5	84	557	—	—	1·0	11	4	3	13	—	6·4	16	0·91
SALISBURY (Wilton House), Wilts, THOMAS CHALLIS, Esq.	186	Oct.	29·793	1·128	65·0	29·0	36·0	58·4	40·5	17·9	49·8	45·7	·308	3·7	0·3	85	542	85·3	39·3	1·2	9	4	8	10	—	7·0	22	3·06
		Nov.	29·629	1·434	59·0	21·0	38·0	50·6	31·9	18·7	44·5	41·0	·257	3·0	0·4	86	544	70·3	30·7	1·1	6	5	7	12	—	6·2	25	3·02
		Dec.	29·974	0·986	54·0	18·0	36·0	45·3	34·7	10·6	40·0	36·8	·218	2·5	0·4	89	556	59·1	31·1	1·2	13	3	5	10	—	7·2	21	0·99
BARNSTAPLE (Devon), WILLIAM KNILL, Esq.	41	Oct.	29·955	1·190	65·0	41·0	24·0	59·0	49·1	9·9	53·1	48·3	·319	3·9	0·7	83	542	—	—	1·3	4	4	10	13	—	4·4	16	5·02
		Nov.	29·809	1·140	58·0	28·0	30·0	52·0	41·7	10·3	46·7	41·8	·286	3·1	0·6	83	545	—	—	1·4	4	5	9	12	—	5·0	23	7·61
		Dec.	30·197	0·870	56·0	29·5	26·5	48·4	39·7	8·7	44·1	39·7	·245	2·8	0·5	84	552	—	—	1·3	11	4	6	10	—	4·1	16	2·91
STRATHFIELD TURGISS (Hants), REV. C. H. GRIFFITH, M.A., F. R. Met. Soc.	197	Oct.	29·779	1·128	62·2	34·9	27·3	57·5	42·6	14·9	49·6	45·7	·313	3·6	0·5	87	541	91·4	36·7	1·0	7	2	9	13	1·7	6·8	14	1·82
		Nov.	29·637	1·389	56·6	23·4	33·2	50·3	36·4	13·9	43·2	39·9	·247	2·8	0·5	89	546	78·1	29·1	0·8	6	1	7	16	1·4	5·3	22	2·55
		Dec.	29·974	1·016	54·2	22·1	32·1	45·0	34·5	10·5	40·1	36·7	·217	2·5	0·4	88	553	57·0	29·1	1·1	10	4	4	13	1·3	7·3	15	0·57

Names of Stations and Observers.	Height of Station above Sea Level.	Year 1883. Months.	Pressure of Atmosphere in Month. Mean.	Pressure Range.	Temperature of Air in Month. Highest.	Lowest.	Range.	Mean Of all Highest.	Mean Of all Lowest.	Mean Daily Range.	Mean Temperature. Air.	Dew Point.	Vapour. Elastic Force.	In a Cubic foot of Air. Mean.	Short of Saturation.	Mean Degree of Humidity. Satn. = 100.	Mean Weight of a cubic foot of Air.	Mean Reading of Thermometer. Maximum in Rays of Sun.	Minimum on Grass.	Wind. Estimated Strength.	Relative Proportion of N.	E.	S.	W.	Mean Amount of Ozone.	Mean Amount of Cloud.	Rain. Number of Days it fell.	Amount collected.
	feet.		in.	in.	°	°	°	°	°	°	°	°	in.	grs.	gr.		grs.	°	°									in.
BATH (Somerset), St. Gregory's College, Downside, Rev. T. J. Almond, O.S.B., F. R. Met. Soc.	596	Oct.	29·334	1·180	60·8	38·7	22·1	54·9	44·3	10·6	48·8	45·6	·316	3·5	0·3	91	534	94·5	–	1·5	9	3	8	11	–	6·9	16	4·75
		Nov.	29·162	1·387	53·3	27·2	26·1	48·3	37·5	10·8	43·0	39·7	·244	2·8	0·4	88	537	78·3	35·9	1·4	3	3	10	15	–	6·2	23	6·78
		Dec.	29·531	1·008	52·0	26·3	25·7	43·9	34·6	9·3	39·6	35·9	·211	2·4	0·4	87	548	62·4	31·6	1·6	8	6	4	13	–	7·2	17	2·13
MARLBOROUGH (Wilts), Rev. Thomas A. Preston, M.A., F. R. Met. Soc.	456	Oct.	29·471	1·168	62·1	33·7	28·4	55·9	42·4	13·5	48·6	44·5	·294	3·3	0·5	86	538	95·7	37·7	0·7	6	5	9	11	–	6·6	17	3·12
		Nov.	29·322	1·382	54·1	23·4	30·7	48·4	35·3	13·1	41·8	39·0	·238	2·8	0·4	90	542	76·6	30·5	0·9	3	3	7	17	–	6·5	20	4·17
		Dec.	29·668	1·016	51·4	25·4	26·0	43·5	34·2	9·3	38·9	35·6	·210	2·5	0·3	86	552	58·6	30·5	0·7	9	5	4	13	–	8·0	16	1·02
WHITCHURCH RECTORY (Oxon), (near Reading), Rev. J. Slatter, M.A., F.R. Met. Soc.	150	Oct.	29·824	1·058	63·3	31·0	29·3	56·4	42·0	14·4	49·2	46·1	·318	3·8	0·4	90	543	–	–	1·4	6	6	9	10	–	7·3	10	1·62
		Nov.	29·669	1·262	55·0	24·7	30·3	49·0	34·2	14·8	41·7	40·1	·247	2·9	0·2	94	548	–	–	1·0	4	2	9	15	–	5·3	16	2·75
		Dec.	30·010	0·951	55·0	26·7	28·3	44·5	35·0	9·5	40·2	37·5	·224	2·6	0·3	94	556	–	–	1·1	10	6	4	11	–	7·8	15	0·62
BLACKHEATH (Kent), James Glaisher, Esq., F.R.S.	150	Oct.	29·806	1·121	64·8	37·0	27·8	56·4	44·9	11·5	50·5	45·2	·302	3·5	0·6	82	541	81·0	37·9	1·2	5	5	7	14	–	6·9	15	1·54
		Nov.	29·643	1·457	55·5	29·5	26·5	48·7	37·7	11·0	43·5	39·1	·237	2·8	0·5	83	546	74·8	30·8	0·7	3	3	8	16	–	5·8	17	3·12
		Dec.	29·982	1·075	53·5	29·0	24·5	43·8	36·0	7·8	40·4	36·1	·223	2·5	0·5	85	556	53·4	29·8	1·0	8	4	4	15	–	8·1	11	0·76
ROYAL OBSERVATORY, Greenwich, W. H. M. Christie, M.A., F.R.S., Astronomer Royal.	159	Oct.	29·800	1·110	64·6	36·7	27·9	57·1	44·5	12·6	50·4	46·2	·313	3·6	0·6	86	541	86·4	37·6	–	–	–	–	–	2·2	7·2	14	1·59
		Nov.	29·659	1·427	56·2	27·8	28·4	49·6	37·5	11·8	43·8	39·8	·245	2·8	0·5	86	546	69·7	33·5	–	–	–	–	–	1·9	5·9	21	2·84
		Dec.	29·983	1·065	54·2	28·4	25·8	44·1	36·1	8·0	40·5	36·3	·214	2·5	0·5	85	555	52·5	32·9	–	–	–	–	–	1·4	8·0	15	0·83
CAMDEN SQUARE (London), G. J. Symons, Esq., F.R.S., F. R. Met. Soc.	123	Oct.	29·841	1·121	64·6	36·9	27·7	57·7	45·0	12·7	50·6	45·9	·317	3·6	0·5	86	541	81·1	39·7	–	9	2	3	15	–	5·9	14	1·75
		Nov.	29·696	1·461	55·8	28·7	27·1	49·9	37·2	12·7	43·8	39·7	·245	2·8	0·5	85	547	65·7	32·6	–	8	1	6	15	–	6·7	16	2·78
		Dec.	30·027	1·061	54·9	28·3	26·6	44·9	36·4	8·5	40·9	36·6	·216	2·5	0·5	89	556	54·5	38·7	–	9	3	3	16	–	7·4	14	0·75
BARNET (Gas Works), T. H. Martin, Esq., C.E.	212	Oct.	29·774	1·128	65·0	29·0	36·0	57·8	42·4	15·4	49·7	46·4	·315	3·6	0·5	89	541	–	39·4	0·7	8	6	2	15	–	7·1	18	1·67
		Nov.	29·629	1·423	56·5	25·6	30·9	49·5	35·0	14·5	42·2	38·2	·231	2·7	0·5	86	547	–	35·8	0·5	8	3	2	17	–	6·4	17	2·93
		Dec.	29·963	0·949	55·0	26·8	28·2	44·1	35·0	9·1	39·9	35·8	·210	2·4	0·5	84	556	–	32·2	1·0	11	5	3	12	–	8·0	15	1·11
OXFORD (The Observatory), E. J. Stone, Esq., M.A., F.R.S.	210	Oct.	29·764	1·981	61·7	38·7	25·0	56·9	45·3	11·6	50·5	46·5	·317	3·6	0·5	87	540	96·5	39·9	2·6	6	4	10	11	0·8	6·7	12	1·89
		Nov.	29·588	1·410	57·2	27·0	30·2	50·4	38·1	12·3	43·8	40·1	·249	2·9	0·4	87	544	80·6	32·7	2·8	3	3	12	12	0·4	5·7	16	2·83
		Dec.	29·946	1·051	54·7	27·5	27·2	45·5	37·2	8·3	40·9	37·1	·220	2·6	0·4	86	534	64·6	32·6	3·3	6	2	8	15	1·0	7·5	13	0·71
ROYSTON (Hertfordshire), Hale Wortham, Esq., F.R.A.S., F. R. Met. Soc.	269	Oct.	29·673	1·142	63·4	35·5	27·9	56·6	43·9	12·7	49·2	45·8	·310	3·6	0·4	89	540	–	–	–	6	4	9	11	–	6·4	13	1·74
		Nov.	29·548	1·425	55·0	26·0	29·0	48·7	36·3	12·4	42·3	38·1	·231	2·6	0·3	85	545	–	–	–	4	2	10	14	–	4·7	22	2·64
		Dec.	29·871	1·089	53·5	27·6	25·9	41·5	35·7	7·8	39·5	35·5	·209	2·4	0·5	86	555	–	–	–	7	3	6	15	–	7·6	13	1·07
BEDFORD, Cardington, Mr. J. McLaren, Assistant to S. Whitbread, Esq., M.P.	105	Oct.	29·861	1·164	65·2	32·5	27·7	57·6	43·6	14·0	49·9	45·8	·310	3·5	0·6	99	542	70·5	39·5	2·2	9	3	6	13	–	6·1	13	1·65
		Nov.	29·709	1·400	56·4	24·0	32·4	49·3	35·3	14·0	42·0	38·7	·235	2·7	0·4	88	549	53·4	31·2	1·8	4	1	5	20	–	4·9	19	2·68
		Dec.	30·051	0·970	55·0	26·0	29·0	44·1	35·0	9·1	39·5	36·9	·220	2·6	0·3	93	555	45·7	32·6	1·6	9	2	5	15	—	7·3	8	0·77
CAMBRIDGE (Trinity College), J. W. L. Glaisher, Esq., M.A., F.R.S.	40	Oct.	29·891	1·152	65·5	36·0	29·5	58·1	44·3	13·8	50·4	46·4	·315	3·6	0·5	87	542	97·1	37·0	1·4	5	3	8	15	–	6·2	16	1·38
		Nov.	29·774	1·400	58·5	22·8	35·7	49·3	36·1	13·3	42·5	40·4	·239	2·8	0·2	96	549	74·0	29·1	1·3	2	2	14	12	–	5·5	22	2·80
		Dec.	30·050	0·994	56·0	26·5	29·5	43·9	36·0	7·9	40·1	37·1	·221	2·6	0·3	89	558	59·4	31·8	1·5	8	3	6	14	–	7·9	18	1·30
RUGBY (Warwickshire), Stockton, The Rectory, Rev. W. Tuckwell.	289	Oct.	29·6 6	1·364	64·0	33·4	32·6	56·5	41·5	15·0	48·3	45·4	·305	3·4	0·5	90	540	–	–	0·5	5	6	11	9	–	6·8	16	1·77
		Nov	29·442	1·286	55·8	19·0	36·8	48·5	33·1	15·4	40·3	38·8	·236	2·7	0·2	96	546	–	–	0·5	2	6	10	12	–	6·4	20	3·13
		Dec.	29·780	1·034	55·0	24·9	30·1	44·7	34·4	10·3	39·7	36·2	·213	2·5	0·3	88	553	–	–	0·5	6	1	11	13	–	7·8	10	0·59
LOWESTOFT (Suffolk), S. H. Miller, Esq., F.R.A.S., F. R. Met. Soc.	89	Oct.	29·821	1·202	66·5	37·0	29·5	56·3	46·1	10·2	51·2	46·1	·318	3·6	0·9	83	540	90·5	43·7	2·3	4	5	7	15	–	7·0	20	2·49
		Nov	29·650	1·486	56·7	31·0	25·7	48·7	37·9	10·8	43·3	39·2	·241	2·7	0·5	85	546	77·1	35·0	2·4	6	1	4	20	–	6·7	21	3·50
		Dec.	29·977	1·188	53·6	29·2	24·4	44·5	35·6	8·9	40·3	35·7	·209	2·4	0·3	84	556	63·2	33·4	2·9	9	4	4	14	–	8·1	17	2·10
SOMERLEYTON (Suffolk), The Rectory, Rev. C. J. Steward, F. R. Met. Soc.	50	Oct.	29·870	1·180	67·3	36·0	31·3	57·0	45·5	11·5	50·3	48·5	·330	3·7	0·4	88	542	–	–	1·0	5	3	11	12	4·5	5·6	16	2·84
		Nov.	29·722	1·398	54·7	28·1	26·6	49·2	37·6	11·6	42·9	40·0	·246	2·8	0·4	89	548	–	–	1·1	4	1	12	13	4·5	5·9	21	3·93
		Dec.	30·035	1·120	54·8	28·2	26·6	43·8	35·8	8·0	39·6	36·4	·213	2·5	0·3	89	558	–	–	1·0	8	3	5	15	4·2	7·7	17	2·28

Names of Stations and Observers.	Height of Station above Sea Level.	Year 1883. Months.	Pressure of Atmosphere in Month. Mean.	Pressure of Atmosphere in Month. Range.	Temperature of Air in Month. Highest.	Temperature of Air in Month. Lowest.	Temperature of Air in Month. Range.	Temperature of Air in Month. Mean. Of all Highest.	Temperature of Air in Month. Mean. Of all Lowest.	Temperature of Air in Month. Mean. Daily Range.	Mean Temperature. Air.	Mean Temperature. Dew Point.	Vapour. Elastic Force.	Vapour. In a cubic foot of Air. Mean.	Vapour. In a cubic foot of Air. Short of Saturation.	Mean Degree of Humidity. Sat^n. = 100.	Mean Weight of a cubic foot of Air.	Mean Reading of Thermometer. Maximum in Rays of Sun.	Mean Reading of Thermometer. Minimum on Grass.	Wind. Estimated Strength.	Wind. Relative Proportion of N.	E.	S.	W.	Mean Amount of Ozone.	Mean Amount of Cloud.	Rain. Number of Days it fell.	Rain. Amount collected.
	feet.		in.	in.	°	°	°	°	°	°	°	°	in.	grs.	gr.		grs.	°	°									in.
WOLVERHAMPTON (Staffordshire), Wrottesley, E. Simpson, Esq.	500	Oct.	29.435	1.274	61.3	33.7	27.6	54.0	40.7	13.3	47.0	44.1	.289	3.3	0.4	90	538	—	—	—	5	5	12	9	—	7.6	18	2.58
		Nov.	29.252	1.382	55.9	23.9	32.0	46.6	33.2	13.4	40.2	37.0	.220	2.5	0.5	89	542	—	—	—	2	1	16	11	—	7.0	18	4.41
		Dec.	29.633	1.030	54.0	23.3	30.7	44.1	33.2	10.9	39.1	34.3	.198	2.3	0.5	85	551	—	—	—	6	1	10	14	—	8.8	12	0.91
LEICESTER (Town Museum), J. C. Smith, Esq.	238	Oct.	29.670	1.288	64.2	37.0	27.2	56.5	43.8	12.7	49.7	44.9	.300	3.3	0.8	85	539	89.1	35.2	0.8	7	3	9	12	—	6.4	23	2.24
		Nov.	29.502	1.385	56.0	23.0	33.0	47.8	35.9	11.9	41.9	38.1	.230	2.7	0.4	88	545	67.8	29.0	0.9	3	2	12	13	—	5.6	21	3.51
		Dec.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
NOTTINGHAM (Notts), M. O. Tarbotton, Esq., C.E., F.G.S., F. R. Met. Soc.	183	Oct.	29.724	1.258	66.3	33.2	33.1	56.2	42.6	13.6	48.8	43.6	.285	3.2	0.6	82	541	77.8	39.3	0.3	5	5	6	15	0.9	6.0	28	2.42
		Nov.	29.542	1.404	56.2	21.0	35.2	47.5	34.8	12.7	41.1	38.6	.234	2.7	0.3	91	546	62.1	31.8	0.3	4	5	12	9	1.2	6.6	25	3.32
		Dec.	29.912	1.072	54.2	28.2	26.0	44.5	35.6	8.9	40.3	36.1	.212	2.4	0.3	85	554	52.1	32.1	0.4	7	6	7	11	0.6	7.8	27	1.50
HOLKHAM (Norfolk), John Davidson, Esq., Assistant to the Earl of Leicester.	39	Oct.	29.845	1.176	63.3	32.7	30.6	55.8	41.3	14.5	48.9	45.3	.304	3.4	0.5	88	543	85.2	38.2	1.6	7	4	10	10	—	6.2	15	3.12
		Nov.	29.690	1.422	55.3	23.7	31.6	48.1	34.4	13.7	41.9	38.5	.235	2.7	0.4	89	548	58.8	30.1	1.7	4	1	10	6	—	6.0	19	3.14
		Dec.	30.011	1.086	51.6	26.3	27.3	44.1	33.6	10.5	39.9	36.1	.212	2.5	0.4	87	557	47.2	23.4	2.1	7	3	9	12	—	7.2	17	1.74
BURSLEM, J. E. Worth, Esq., C.E., F. R. Met. Soc.	556	Oct.	29.322	1.327	60.4	30.0	30.4	53.1	42.0	11.1	46.9	43.8	.286	3.2	0.4	93	536	—	—	0.9	4	4	9	14	—	6.7	23	4.26
		Nov.	29.133	1.397	54.0	27.6	26.4	45.9	35.6	10.3	40.5	37.8	.227	2.6	0.3	90	540	—	—	1.0	4	1	13	11	—	7.3	23	3.19
		Dec.	29.512	1.146	51.9	23.7	28.2	42.7	35.3	7.4	39.1	35.9	.212	2.4	0.4	83	548	—	—	1.1	6	2	6	17	—	8.1	25	2.22
LLANDUDNO (Carnarvonshire), James Nicol, Esq., M.D.	100	Oct.	29.818	1.380	61.0	38.5	22.5	54.9	47.0	7.9	51.0	46.7	.321	3.6	0.6	85	540	—	—	1.1	7	1	6	17	—	6.5	20	4.11
		Nov.	29.617	1.130	50.0	31.8	27.2	50.0	41.0	9.0	45.7	39.9	.247	2.8	0.3	81	543	—	—	1.2	2	2	5	21	—	7.1	19	2.71
		Dec.	30.008	1.310	54.0	32.5	21.5	47.2	40.2	7.0	44.0	39.6	.244	2.8	0.5	84	552	—	—	1.3	7	3	5	16	—	8.6	13	2.05
LIVERPOOL, The Observatory, John Hartnup, Esq., F.R.A.S.	197	Oct.	29.700	1.384	60.9	38.1	22.8	54.1	46.0	8.1	49.1	44.7	.297	3.4	0.6	85	540	—	—	—	3	7	7	14	—	7.1	16	5.00
		Nov.	29.514	1.481	58.1	32.6	25.5	48.5	40.0	8.5	43.6	37.9	.230	2.6	0.4	80	543	—	—	—	4	2	10	14	—	6.3	21	2.30
		Dec.	29.918	1.152	55.0	30.5	24.5	46.1	39.1	7.0	42.2	38.2	.231	2.7	0.4	86	552	—	—	—	4	2	8	17	—	7.8	19	1.97
BOLTON, Sharples (Lancashire), Rev. T. Mackereth, F.R.A.S., F. R. Met. Soc.	500	Oct.	29.372	1.344	57.4	30.6	26.8	53.0	41.7	11.3	47.0	43.2	.279	3.2	0.5	87	537	62.2	40.1	0.7	5	4	10	12	2.5	7.5	17	6.35
		Nov.	29.188	1.446	55.1	28.1	27.0	46.1	35.7	10.4	40.8	37.8	.227	2.6	0.3	89	540	52.0	34.0	0.9	5	4	10	11	2.4	7.1	22	5.86
		Dec.	29.561	1.262	51.1	25.2	25.9	43.2	35.1	8.1	39.3	36.1	.218	2.5	0.4	89	549	46.0	33.3	1.1	8	6	11	6	4.1	7.9	22	5.56
HALIFAX, Bermerside Observatory (Yorkshire), E. J. Crossley, Esq., F.R.A.S.	530	Oct.	29.382	1.334	65.0	30.0	35.0	53.7	41.4	12.3	46.7	43.3	.281	3.3	0.4	89	537	71.6	39.0	1.0	4	5	10	12	—	7.0	17	4.43
		Nov.	—	1.484	55.0	26.0	29.0	45.6	35.9	9.7	40.5	36.6	.217	2.5	0.5	88	541	64.5	32.7	1.1	3	1	10	16	—	6.9	19	4.66
		Dec.	29.553	1.171	52.0	21.3	30.7	42.0	33.6	8.4	38.5	35.1	.204	2.4	0.4	89	548	53.1	32.2	1.2	4	3	9	15	—	8.2	13	2.18
HULL (Yorkshire), The People's Park, Mr. E. Peak.	12	Oct.	29.878	1.198	67.0	34.0	33.0	56.2	41.4	14.8	48.9	43.6	.283	3.6	0.7	83	544	—	40.0	1.6	4	3	8	16	—	5.5	17	3.58
		Nov.	29.712	1.240	55.0	27.0	28.0	47.5	35.8	11.7	42.2	38.0	.227	2.6	0.4	85	549	—	34.8	1.7	4	1	9	16	—	5.5	24	2.79
		Dec.	30.093	1.414	53.0	29.0	24.0	43.3	34.4	8.9	40.0	35.7	.209	2.4	0.5	85	558	48.8	34.0	1.6	8	4	5	14	—	7.3	17	1.33
STONYHURST (Lancashire), Rev. S. J. Perry, F.R.S., F. R. Met. Soc., F.R.A.S.	363	Oct.	29.518	1.370	62.1	33.1	29.0	55.3	41.6	13.7	48.0	43.4	.281	3.2	0.6	85	539	89.3	42.3	—	7	2	6	16	—	8.0	19	5.76
		Nov.	29.326	1.475	56.5	23.1	35.4	47.6	35.1	12.5	41.2	37.6	.219	2.6	0.4	88	543	81.0	32.9	—	5	4	5	16	—	7.7	23	5.26
		Dec.	29.709	1.839	51.0	20.7	30.3	44.7	34.0	10.7	39.8	35.9	.211	2.4	0.5	87	551	60.8	32.1	—	6	2	4	19	—	8.7	21	4.90
BRADFORD (Yorkshire), J. McLandsborough, Esq., C.E., F.G.S.	366	Oct.	29.493	1.310	62.4	33.6	28.8	54.2	44.3	9.9	48.4	43.4	.281	3.2	0.6	83	537	66.9	—	1.2	10	4	6	11	—	7.2	18	3.65
		Nov.	29.349	1.438	56.2	29.2	27.0	46.9	38.2	8.7	42.4	36.8	.219	2.5	0.6	81	542	54.0	—	1.1	5	3	10	12	—	7.1	22	3.11
		Dec.	29.677	1.158	54.0	29.0	25.0	45.1	37.1	8.0	41.2	36.5	.215	2.5	0.5	84	549	49.5	—	1.5	9	5	3	14	—	7.3	14	1.32
LEEDS (Yorkshire), The Philosophical Hall, Henry Crowther, Esq.	137	Oct.	29.743	1.328	66.0	34.0	32.0	55.5	45.0	10.5	49.5	46.0	.311	3.6	0.5	89	541	—	—	1.2	6	4	6	15	—	7.0	15	2.60
		Nov.	29.581	1.464	58.0	30.0	28.0	48.2	39.4	8.8	44.0	39.2	.240	2.8	0.5	83	544	—	—	1.2	5	3	5	17	—	7.2	20	2.53
		Dec.	29.919	1.168	55.0	31.0	24.0	44.2	38.7	5.5	42.1	37.2	.224	2.6	0.5	83	553	—	—	1.4	4	3	4	20	—	8.0	13	1.06
LANCASTER (Southfields), William Roper, Esq.	114	Oct.	29.764	1.410	59.0	29.0	30.0	54.7	42.5	12.2	48.0	42.7	.273	3.1	0.6	83	543	—	—	—	—	—	—	—	—	—	17	4.57
		Nov.	29.563	1.486	57.0	25.0	32.0	48.3	37.2	11.1	43.0	38.8	.236	2.7	0.5	85	545	—	—	—	—	—	—	—	—	—	21	4.99
		Dec.	29.964	1.116	50.0	24.0	26.0	46.0	36.2	9.8	41.6	38.9	.236	2.7	0.3	90	554	—	—	—	—	—	—	—	—	—	19	2.59

Names of Stations and Observers.	Height of Station above Sea Level.	Year 1883. Months.	Pressure of Atmosphere in Month. Mean.	Range.	Temperature of Air in Month. Highest.	Lowest.	Range.	Mean Of all Highest.	Of all Lowest.	Daily Range.	Mean Temperature. Air.	Dew Point.	Vapour. Elastic Force.	In a cubic foot of Air. Mean.	Short of Saturation.	Mean Degree of Humidity. Satn. = 100.	Mean Weight of a cubic foot of Air.	Mean Reading of Thermometer. Maximum in Rays of Sun.	Minimum on Grass.	Wind. Estimated Strength.	Relative Proportion of N.	E.	S.	W.	Mean Amount of Ozone.	Mean Amount of Cloud.	Rain. Number of Days it fell.	Amount collected.
	feet.		in.	in.	°	°	°	°	°	°	°	°	in.	grs.	gr.		grs.	°	°									in.
SILLOTH (Cumberland), "The Rectory," REV. F. REDFORD, M.A., F.R.A.S., F. R. Met. Soc.	28	Oct.	29·834	1·548	59·8	26·0	33·8	54·6	41·8	12·8	47·6	43·4	·281	3·2	0·5	86	545	93·0	38·1	1·4	7	6	5	13	7·4	4·7	16	3·16
		Nov.	29·622	1·652	54·4	24·0	30·4	46·7	38·1	8·6	42·0	39·1	·239	2·7	0·6	89	547	79·1	35·1	1·7	8	4	5	13	8·7	6·3	24	4·54
		Dec.	30·036	1·671	49·6	22·6	27·0	43·9	37·2	6·7	40·9	38·4	·253	2·8	0·3	92	556	58·5	34·1	1·6	7	3	5	16	7·9	6·7	17	3·01
CARLISLE, Spital (Cumberland). ISAAC CARTMEL, ESQ., F. R. Met. Soc	114	Oct.	29·735	1·488	63·8	25·2	38·6	55·7	39·6	16·1	47·4	41·9	·273	3·1	0·6	84	543	72·2	32·8	0·9	5	4	6	16	2·9	7·5	19	3·20
		Nov.	29·528	1·626	57·4	20·8	36·6	48·1	35·2	12·9	41·4	38·1	·251	2·7	0·2	95	546	52·0	28·2	0·9	5	6	5	14	3·3	8·2	23	3·96
		Dec.	29·985	1·596	54·5	18·8	35·7	45·1	34·2	10·9	39·7	35·3	·206	2·4	0·4	84	556	47·1	26·8	1·0	1	5	7	18	3·7	7·4	15	2·92

Second Rain-gauges are placed—

	October.		November.	December.	Total in Quarter.
At Oxford, at the height of 22 feet *above the ground*; the amount collected was	1·85 inches.	-	2·77 inches.	0·71 inches.	5·33 inches.
„ Cardington, „ 21 „ „ „	1·61 „	-	2·68 „	0·78 „	5·07 „
„ Nottingham, „ 39 „ „ „	2·92 „	-	2·91 „	1·33 „	7·16 „
„ Holkham „ 4 „ „ „	3·37 „	-	2·37 „	2·00 „	8·74 „

Hail fell in October, on the 3rd at Torquay and Llandudno; on the 15th at Torquay; on the 16th at Bolton; on the 17th at Whitchurch, Stonyhurst, and Silloth; on the 18th at Stonyhurst and Carlisle; on the 19th at Bolton, Stonyhurst, Lancaster, and Silloth; on the 20th at Torquay, Marlborough, and Bolton; on the 21st at Plymouth; and on the 26th at Torquay.

In November, on the 4th at Stonyhurst; on the 7th and 8th at Guernsey; on the 9th at Stonyhurst; on the 10th at Guernsey, Llandudno, and Stonyhurst; on the 14th at Royston; on the 16th at Guernsey; on the 17th at Osborne, Salisbury, Bath, Oxford, Rugby, Llandudno, and Bolton; on the 18th at Llandudno; on the 19th at Bath, Rugby, Llandudno, Bolton, Halifax, Stonyhurst, Lancaster, and Carlisle; on the 20th at Bath, Barnet, Cardington,

In November, on the 1st at Bath, Oxford, Rugby, Wolverhampton, and Llandudno; on the 2nd at Bath, Marlborough, Blackheath, Barnet, Oxford, Royston, Cardington, Rugby, Wolverhampton, Llandudno, and Bolton; on the 3rd at Bath, Marlborough, Blackheath, Barnet, Oxford, Royston, and Rugby; on the 4th at Marlborough; on the 7th at Marlborough, Blackheath, Barnet, and Bolton; on the 8th at Marlborough, Oxford, Royston, and Wolverhampton; on the 9th at Barnet; on the 11th at Torquay; on the 13th at Bath, Blackheath, Rugby, and Wolverhampton; on the 14th at Bath, Marlborough, Blackheath, Wolverhampton, and Bolton; on the 15th at Bath, Marlborough, Blackheath, Cardington, and Wolverhampton; on the 16th at Wolverhampton, Llandudno, and Bradford; on the 18th at Torquay; on the 23rd at Black-

·teorological Tables, Quarter ending December 31st, 1883.

Mean Pressure of dry Air reduced to the level of the sea.	Highest Reading of the Thermometer.	Lowest Reading of the Thermometer.	Range of Temperature in the Quarter.	Mean of all Highest.	Mean of all Lowest.	Mean Monthly Range of Temperature.	Mean Daily Range of Temperature.	Mean Temperature of the Air.	Mean Temperature of the Dew Point.	Mean Elastic Force of Vapour.	Mean Weight of Vapour in a cubic foot of Air.	Mean additional Weight required for saturation.	Mean degree of Humidity.	Mean Weight of a cubic foot of Air.	Mean Reading of Maximum in Rays of Sun.	Mean Reading of Minimum on Grass.	Wind: Mean Estimated Strength.	Wind: Relative Proportion of N.	E.	S.	W.	Mean Amount of Ozone.	Mean Amount of Cloud.	Rain: Number of Days on which it fell.	Rain: Amount collected.
	°	°	°	°	°	°	°	°	°	in.	grs.	gr.		grs.	°	°									in.
751	62·0	31·0	31·0	52·5	44·7	21·1	7·7	48·2	43·5	·285	3·2	0·6	85	540	83·5	40·5	1·2	7	5	7	12	3·2	7·4	61	11·40
734	64·0	24·0	34·0	51·3	43·2	31·3	11·1	48·1	42·2	·283	3·2	0·5	85	545	—	—	2·2	6	7	6	11	—	7·2	58	11·56
771	62·0	28·0	34·0	52·7	41·4	23·0	11·3	46·9	43·4	·284	3·2	0·5	88	543	—	—	1·4	8	5	4	13	—	6·9	60	8·47
721	65·3	21·7	43·6	52·8	39·8	33·8	13·0	44·4	41·7	·268	3·1	0·6	85	549	—	—	2·4	5	5	6	14	—	6·7	61	11·68
708	64·2	28·1	36·1	52·0	41·7	27·0	10·4	46·7	42·5	·274	3·2	0·6	85	543	85·6	34·1	1·5	7	4	7	13	4·6	7·0	54	8·22
710	64·4	29·3	35·1	52·6	43·5	24·2	9·1	47·7	43·1	·284	3·3	0·6	85	544	—	—	1·2	8	6	4	13	6·5	6·9	46	9·21
[illegible]	64·0	27·0	37·0	51·5	40·2	23·5	11·3	49·0	42·6	·244	3·1	0·4	89	547	76·5	39·1	0·2	7	4	7	13	—	6·6	46	7·55
737	61·0	26·0	35·0	49·5	40·1	25·8	9·4	44·7	40·6	·253	3·0	0·5	85	547	—	36·2	1·2	9	5	5	12	—	6·5	51	7·58
757	62·1	24·2	38·9	51·5	40·9	29·8	10·6	44·1	41·3	·263	3·0	0·5	84	548	—	—	1·1	10	3	4	13	—	5·8	47	6·72
740	65·0	18·0	47·0	51·4	35·7	36·7	15·7	44·6	41·2	·261	3·1	0·4	87	547	71·6	33·7	1·2	9	4	7	11	—	6·8	68	7·97
718	65·0	28·0	37·0	53·1	43·5	26·8	9·6	48·0	43·3	·287	3·3	0·6	83	546	—	—	1·3	6	4	8	12	—	4·5	55	15·34
715	59·8	26·3	33·5	49·0	38·8	24·6	10·2	43·8	40·4	·257	2·9	0·4	89	540	78·4	—	1·5	7	4	7	13	—	6·8	56	13·66
752	62·2	22·1	40·1	50·9	37·8	30·9	13·1	44·3	40·8	·259	3·0	0·5	88	548	75·5	31·6	1·0	8	2	6	14	1·5	6·5	53	4·94
751	62·1	23·4	38·7	49·6	37·3	28·4	12·0	43·1	39·7	·247	2·9	0·4	87	544	77·0	32·9	0·8	6	4	7	14	—	7·0	53	8·31
745	62·3	24·7	37·6	50·0	37·1	29·5	12·9	43·7	41·2	·261	3·1	0·3	93	549	—	—	1·2	7	5	7	12	—	6·8	41	4·99
721	64·8	29·0	35·8	49·6	39·5	21·3	10·1	44·5	40·1	·254	2·9	0·5	83	548	69·7	32·8	1·0	5	4	6	15	—	6·9	43	5·42
731	64·6	28·4	36·2	50·3	39·5	27·4	10·8	44·9	40·8	·257	3·0	0·5	86	547	69·5	34·7	—	—	—	—	—	1·8	7·0	50	5·26
750	61·6	28·3	36·3	50·8	39·5	27·1	11·5	45·1	40·7	·259	3·0	0·5	87	548	67·1	35·3	—	9	2	4	15	—	6·7	44	5·28
758	65·0	25·6	39·4	50·8	37·5	31·7	13·3	43·9	40·1	·252	2·9	0·5	86	548	—	35·8	0·7	9	5	2	15	—	7·2	50	5·71
783	63·7	27·0	36·7	50·9	40·2	27·5	10·7	45·1	41·2	·262	3·0	0·4	87	546	80·6	35·1	2·9	5	3	10	13	0·7	6·6	41	5·43
740	63·4	26·0	37·4	49·6	38·6	27·6	11·0	40·3	39·8	·250	2·9	0·4	87	547	—	—	—	6	3	8	13	—	6·2	48	5·45
734	65·2	24·0	41·2	50·3	38·0	29·7	12·4	43·8	40·5	·255	2·9	0·4	95	550	56·5	34·4	1·9	7	2	5	16	—	6·1	39	5·10
701	65·5	22·8	42·7	50·5	38·8	31·9	11·7	44·3	41·3	·258	3·0	0·3	91	550	76·8	32·6	1·4	5	3	9	14	—	6·5	56	5·48
674	61·0	19·0	45·0	49·9	36·3	33·2	13·6	42·8	40·1	·251	2·9	0·3	91	546	—	—	0·5	4	4	11	11	—	7·0	46	5·49
660	65·5	29·2	37·3	49·8	39·8	25·5	10·0	41·9	40·3	·254	2·9	0·6	84	547	76·9	37·4	2·5	6	3	5	16	—	7·3	58	8·09
679	67·3	28·1	39·2	50·0	39·6	28·2	10·4	44·3	41·6	·263	3·0	0·4	89	549	—	—	1·0	6	2	9	13	4·4	6·4	54	9·05
749	61·3	24·3	38·0	48·2	35·7	30·1	12·5	42·1	38·5	·236	2·7	0·5	88	544	—	—	—	4	2	13	11	—	7·8	48	7·90
681	64·3	21·0	45·3	49·4	37·7	31·4	11·7	41·4	39·4	·244	2·8	0·4	86	547	64·0	34·4	0·3	5	5	8	12	0·9	6·8	82	7·21
642	64·3	21·7	43·6	49·3	36·4	29·8	12·9	43·6	40·0	·250	2·9	0·4	88	549	63·7	32·2	1·8	6	3	13	9	—	6·5	51	8·00
658	61·4	23·7	33·7	47·2	37·6	28·3	9·6	42·2	39·2	·242	2·7	0·4	90	541	—	—	1·0	5	2	9	14	—	7·4	71	9·67
819	61·0	31·8	29·2	50·7	42·7	23·7	8·0	46·9	42·1	·271	3·1	0·5	83	545	—	—	1·2	5	2	5	18	—	7·4	52	8·87
654	60·9	30·5	30·4	49·6	41·7	24·3	7·9	45·0	40·3	·253	2·9	0·5	84	545	—	—	—	4	4	8	15	—	7·1	56	9·27
675	57·4	25·2	32·2	47·4	37·5	25·6	9·9	42·4	39·0	·240	2·8	0·4	88	542	53·1	35·8	0·9	6	5	10	10	3·0	7·5	61	17·77
—	65·0	21·3	43·7	47·1	37·0	31·6	10·1	41·9	38·3	·234	2·7	0·4	88	542	63·1	34·6	1·1	4	3	10	14	—	7·4	49	11·27
633	67·0	27·0	40·0	49·0	37·2	28·3	11·8	43·7	39·1	·241	2·9	0·5	84	550	—	36·3	1·6	5	3	7	15	—	6·1	58	7·70
676	62·1	20·7	41·4	49·2	36·9	31·6	12·3	43·0	39·0	·237	2·7	0·5	87	544	77·0	35·8	—	6	3	5	17	—	8·1	63	15·91
655	62·4	29·0	33·4	48·7	39·9	24·9	8·9	44·0	38·9	·238	2·7	0·6	83	543	56·8	—	1·3	8	4	6	12	—	7·2	54	6·18
611	66·0	30·0	36·0	49·3	41·0	28·0	8·3	45·2	40·8	·258	3·0	0·5	85	546	—	—	1·3	5	3	5	17	—	7·4	48	6·19
650	59·0	24·0	35·0	49·7	38·6	29·3	11·0	44·2	40·1	·248	2·8	0·5	86	547	—	—	—	—	—	—	—	—	—	57	12·15
604	59·8	22·6	37·2	48·4	39·0	30·4	9·4	43·5	40·3	·258	2·9	0·5	89	549	78·5	35·8	1·5	7	4	5	14	8·0	5·9	57	10·71
620	63·8	18·8	45·0	49·6	36·5	37·0	13·3	42·8	39·1	·237	2·7	0·4	88	545	57·1	32·6	0·9	4	5	6	16	3·3	7·7	57	10·15

...ures of the air were at Somerleyton, 67°·3; at Hull, 67°·0; and at Lowestoft, 66°·5.

...es of the air were at Salisbury, 18°; at Carlisle, 18°·8; and at Rugby, 19°·0.

... temperature were at Salisbury, 15°·7; at Rugby, 13°·6; and at Barnet and Carlisle, 13°·3.

... of temperature were at Guernsey, 7°·7; at Liverpool, 7°·9; and at Leeds, 8°·3.

... days of rain were at Nottingham, 82; at Burslem, 71; and at Salisbury, 68.

... days of rain were at Cardington, 39; at Whitchurch and Oxford, 41; and at Blackheath, 43.

...ain were at Bolton, 17·77 inches; at Stonyhurst, 15·92 inches; and at Barnstaple, 15·54 inches.

... were at Strathfield Turgiss, 4·94 inches; at Whitchurch, 4·99 inches; and at Cardington, 5·10 inches.

...ARTERLY METEOROLOGICAL TABLE for different PARALLELS of LATITUDE.

	Mean Pressure of dry Air reduced to the level of the sea.	Mean of all Highest Readings of the Thermometer.	Mean of all Lowest Readings of the Thermometer.	Mean Range of Temperature in the Quarter.	Mean of all Highest.	Mean of all Lowest.	Mean Monthly Range of Temperature.	Mean Daily Range of Temperature.	Mean Temperature of the Air.	Mean Temperature of the Dew Point.	Mean Elastic Force of Vapour.	Mean Weight of Vapour in a cubic foot of Air.	Mean additional Weight required for saturation.	Mean degree of Humidity.	Mean Weight of a cubic foot of Air.	Mean Reading of Maximum in Rays of Sun.	Mean Reading of Minimum on Grass.	Wind: Mean Estimated Strength.	Wind: Relative Proportion of N.	E.	S.	W.	Mean Amount of Ozone.	Mean Amount of Cloud.	Rain: Mean Number of Days it fell.	Rain: Mean Amount collected.
	in.	°	°	°	°	°	°	°	°	°	in.	grs.	gr.		grs.	°	°									in.
–	29·781	62·0	31·0	31·0	52·5	44·7	21·1	7·7	48·2	43·5	·285	3·2	0·6	85	540	83·5	40·5	1·2	7	5	7	12	3·2	7·4	61	11·40
–	29·773	63·7	26·2	37·5	52·5	41·5	28·4	11·0	47·3	42·4	·271	3·2	0·5	86	547	81·0	36·6	1·4	7	5	5	13	5·5	6·7	52	9·10
–	29·740	63·6	25·5	38·1	50·6	38·8	28·8	11·8	44·6	40·9	·260	3·0	0·4	86	547	73·7	33·9	1·2	7	4	7	13	1·3	6·6	50	7·20
–	29·694	64·3	24·1	40·2	49·4	37·8	29·7	11·6	43·2	40·1	·250	2·9	0·4	84	547	67·6	34·6	1·3	5	3	9	13	2·7	6·8	55	7·15
–	29·662	62·3	26·6	35·7	49·0	39·2	27·8	9·8	44·0	39·7	·247	2·8	0·5	85	545	62·5	35·6	1·2	5	3	7	15	—	7·3	55	10·81
–	29·612	61·8	20·7	41·1	49·0	37·7	33·7	11·3	43·1	39·7	·248	2·8	0·4	88	549	67·8	34·2	0·8	6	4	6	15	6·7	6·8	57	10·45
0	29·648	64·5	21·3	43·3	49·3	38·0	34·1	11·3	43·9	39·1	·241	2·8	0·5	86	548	68·9	33·1	1·3	7	6	6	12	3·4	6·6	50	12·57
1	29·685	63·4	23·6	39·9	50·0	38·9	32·9	11·1	44·5	40·3	·255	2·9	0·5	86	547	72·3	33·5	1·4	4	7	9	11	3·7	6·4	50	9·96
2	29·458	68·1	18·8	49·3	49·3	38·7	36·2	10·6	43·9	40·4	·256	2·9	0·4	88	545	70·5	34·2	1·3	6	7	7	11	4·3	7·2	65	15·07
3	29·696	63·1	24·6	38·5	50·1	39·0	29·7	11·1	44·4	40·6	·255	2·9	0·4	87	545	70·5	35·0	1·2	6	4	7	14	4·1	6·8	54	9·00

METEOROLOGY OF ENGLAND,

DURING THE QUARTER ENDING MARCH 31, 1884.

Remarks on the Weather during the Quarter ending March 31st, 1884.

By James Glaisher, Esq., F.R.S., *&c.*

The weather in January was remarkable; on the 1st there was a fall of snow at many places which was followed by fine weather till the 22nd; this was succeeded by a series of south-westerly gales, and heavy storms occurred on the 26th and 27th with snow generally over the country. The month was very mild; the mean daily temperature was below the average on only two days, viz., the 1st and 27th, and above on every other day, and on some days the excess was as large as 10° and 11°. The mean temperature of the month was 43°·9, being 7°·4 above the average of 113 years, there having been two instances only in this interval in which the mean temperature in January was higher, viz., in the years 1796 and 1834. The readings of the barometer were high till the 22nd day, when a sudden decline took place of three quarters of an inch by the 23rd day, and the readings were low till the end of the month, particularly on the 26th and 27th days. The fall of rain was generally in excess at northern stations, and slightly less than the average at southern stations.

The weather in February was on the whole fine and open; till the 24th there were three days only whose mean temperature were below their averages, and during the middle of the month there were several days which were spring-like and very warm for the season. The pressure of the atmosphere was variable till the 16th, and steadily low afterwards. The fall of rain did not differ much from the average, being a little in excess in some places and a little in default at others; vegetation very forward.

The weather in March was cold during the first three days and during the last week, but singularly mild from the 4th to the 24th. The atmospheric pressure was generally low till the 12th, and high from the 13th; upon the whole the month was remarkably fine and dry, and very favourable for ploughing, spring sowing, and all tillage operations.

About London, with the exception of 3 or 4 days, the temperature was above its average till February 26th, the mean daily excess of these 57 days was 5°·1; from February 27th to March 3rd, the weather was cold, the average daily deficiency of temperature being 3°·8. From March 4th to 24th the weather was fine with much sunshine. On the 15th the excess of temperature over its average was as large as 15°, and it was 14° on the 16th; the mean daily excess of the 5 days March 14th to March 18th was 13°, and of the 21 days ending March 24th it was 5°·4; from the 25th the weather was cold with easterly winds, and the average daily deficiency of temperature was 1°·4.

The mean temperature of the air for January was 43°·9, being 7°·4 and 5°·3 above the averages of 113 years and 43 years respectively; it was 2°·7, 3°·5, and 12°·3 higher than in 1883, 1882, and 1881, respectively.

Back to the year 1771 there have been but 6 Januaries whose mean temperatures have exceeded 43°, viz.:

1796 - 45°·3	1834 - 44°·4	1875 - 43°·4
1804 - 43°·2	1846 - 43°·7	1884 - 43°·9

so that back to 1771, there have been only 2 Januaries of higher temperature, viz., in 1796 and 1834.

The mean temperature of the air for February was 41°·9, being 3°·2 and 2°·4 above the averages of 113 years and 43 years respectively; it was 0°·7 lower than in 1883, 0°·1 higher than in 1882, and 4°·2 higher than in 1881.

Back to the year 1771 there have been 24 previous instances of a mean temperature in February as high as 41°·9:

1775 - 41°·9	1826 - 42°·2	1856 - 42°·0	1869 - 45°·3
1779 - 45°·3	1833 - 42°·4	1859 - 43°·1	1871 - 42°·4
1794 - 44°·7	1846 - 43°·9	1861 - 42°·1	1872 - 44°·8
1809 - 44°·1	1848 - 43°·4	1863 - 42°·1	1877 - 43°·5
1817 - 42°·6	1849 - 43°·2	1867 - 44°·7	1878 - 42°·2
1822 - 43°·3	1850 - 44°·7	1868 - 43°·0	1883 - 42°·6

The mean temperature of the air for March was 44°·5, being 3°·4 and 2°·8 above the averages of 113 years and 43 years respectively; it was 8°·4 higher than in 1883, 1°·5 lower than in 1882, and 1°·9 higher than in 1881.

Back to 1771 there have been but 12 instances of a mean temperature in March being as high as 44°·5, viz.:

1777 - 44°·6	1822 - 47°·3	1871 - 44°·9
1779 - 47°·0	1830 - 45°·8	1872 - 44°·6
1780 - 49°·2	1841 - 46°·2	1882 - 46°·0
1815 - 45°·0	1842 - 44°·9	1884 - 44°·5

The mean temperature for the quarter was 43°·4, being 4°·7 and 3°·5 above the averages of 113 years and 43 years respectively.

Back to 1771 there have been but 3 previous instances of the mean temperature of the quarter ending March exceeding 43°·4, viz.:

1822 - 43°·5	1846 - 43°·6	1872 - 43°·6

The mean temperature of the quarter ending December 1883, was 44°·9 being 1°·5 above the average; the mean temperature of the six months ending March 1884, was 44°·2. The previous instances of the mean temperature of these six months exceeding 44°, back to 1771, are:

1819 - 44°·3	1834 - 44°·2	1849 - 44°·2
1822 - 45°·5	1846 - 44°·7	1877 - 44°·6

so that the period we have just passed, rank as one of the warmest on record.

The mean high day temperature of the air in January was 47°·8, being 4°·9 higher than the average of 43 years, in February it was 47°·7, being 2°·1 higher than the average, and in March was 52°·7, being 2°·8 higher than the average.

The mean low night temperature of the air in January was 39°·2, being 5°·6 higher than the average of 43 years; in February it was 36°·8, being 2°·4 higher than the average, and in March was 37°·4, being 2°·2 higher than the average. Therefore the high day temperatures, and the low night temperatures were warm throughout the quarter, particularly in the month of January.

1884. Months.	Temperature of Air. Mean.	Air. Diff. from average of 113 years.	Air. Diff. from average of 43 years.	Evaporation. Mean.	Evaporation. Diff. from average of 43 years.	Dew Point. Mean.	Dew Point. Diff. from average of 43 years.	Air—Daily Range. Mean.	Air—Daily Range. Diff. from average of 43 years.	Elastic Force of Vapour. Mean.	Elastic Force of Vapour. Diff. from average of 43 years.	Weight of Vapour in a Cubic Foot of Air. Mean.	Weight of Vapour. Diff. from average of 43 years.
	°	°	°	°	°	°	°	°	°	in.	in.	grs.	gr.
Jan. -	43·9	+7·4	+5·3	42·5	+5·6	40·8	+6·0	8·6	−1·2	0·256	+0·061	2·9	+0·3
Feb. -	41·9	+3·2	+2·4	39·9	+2·1	37·5	+2·1	10·9	−0·2	0·225	+0·016	2·6	+0·2
Mar. -	44·5	+3·4	+2·8	41·6	+2·3	38·2	+2·2	15·3	+0·6	0·231	+0·016	2·7	+0·2
Means -	43·4	+4·7	+3·5	41·3	+3·3	38·8	+3·4	11·6	−0·3	0·237	+0·031	2·7	+0·3

1884. Months.	Degree of Humidity. Mean.	Humidity. Diff. from average of 43 years.	Reading of Barometer. Mean.	Barometer. Diff. from average of 43 years.	Weight of a Cubic Foot of Air. Mean.	Weight. Diff. from average of 43 years.	Rain. Amount.	Rain. Diff. from average of 68 years.	Daily Horizontal movement of the Air.	Grass: Number of Nights it was At or below 30°.	Between 30° and 40°.	Above 40°.	Lowest Reading at Night.	Highest Reading at Night.
			in.	in.	grs.	grs.	in.	in.	Miles.				°	°
Jan. -	89	0	29·915	+0·163	550	− 4	1·77	−0·11	404	5	21	5	28·9	41·5
Feb. -	85	0	29·744	−0·048	549	− 4	1·50	−0·09	336	10	15	4	25·0	42·0
Mar. -	79	− 2	29·762	+0·013	547	− 3	1·37	−0·17	266	7	23	1	24·0	41·8
Means -	84	− 1	29·807	+0·043	549	− 4	Sum 4·64	Sum −0·37	Mean 335	Sum 22	Sum 59	Sum 10	Lowest 24·0	Highest 42·0

NOTE.—In reading this table it will be borne in mind that the plus sign (+) signifies *above* the average, and that the minus sign (−) signifies *below* the average.

Average duration of the different directions of the wind referred to eight points of the compass, and duration of each direction in each month in the quarter, were as follows:—

Direction of Wind.	January. 1884.	January. Average.	January. Departure from Average.	February. 1884.	February. Average.	February. Departure from Average.	March. 1884.	March. Average.	March. Departure from Average.
	d.	d.	d.	d.	d.	d.	d.	d.	d.
N.W.	5½	1¾	+ 3¾	1¾	2	− ¼	1½	2¾	−1¼
N.	¾	3½	− 2¾	1	3	−2	2½	3¾	−1¼
N.E.	1½	3¼	− 1¾	1¼	3½	−2¼	6½	4	+2½
E.	½	¾	− ¼	7¼	2	+5¼	3½	2½	+1
S.E.	¼	2¼	− 2	¾	1¼	− ½	5¼	2	+3¼
S.	4½	4¼	+ ¼	6¼	3	+3¼	6¾	2½	+4¼
S.W.	11¾	9¾	+ 2	4½	8	−3½	2¼	7¾	−5½
W.	6½	3½	+ 3	4¾	2¾	+2	2¾	3½	− ¾
Calm.	0	2¼	− 2¼	1½	2½	−1	0	2½	−2½

The plus sign (+) denotes excesses over averages; the largest numbers affected with this sign in the month of January are opposite to N.W. and W.; in February to E. and S.; and March to S. and S.E.

The minus sign (−) denotes deficiencies below averages. In January the largest numbers are opposite to N. and S.E.; in February to S.W. and N.E.; and in March to S.W., N.W., and N.

The mean daily range of temperature in January was 1°·0 smaller than the average, in *February* it was 0°·2 smaller than the average, and in March it was 0·6 greater than the *average.*

The mean temperature of the air in January was 3°·4 higher than in December, in February it was 2°·0 lower than in January, and in March it was 2°·6 higher than in February.

(From the preceding 42 years' observations the decrease of temperature from December to January is 1·4, the increase of temperature from January to February is 1°·1, and the increase from February to March is 2°·1.)

From December to January there was increase of temperature at stations south of 51° of 2°·6, between 51° and 52° of 3°·3, between 52° and 53° of 2°·8, and between 53° and 54° of 2°·2, and north of 54° of 2°·3.

From January to February there was a decrease of temperature at stations south of 51° of 1°·4, between 51° and 52° of 2°·0, between 52° and 53° of 1°·8, between 53° and 54° of 2°·1 and north of 54° of 1°·9.

From February to March there was an increase of temperature at stations south of 51° of 1°·0, between 51° and 52° of 1°·8, between 52° and 53° of 1°·9, between 53° and 54° of 1°·7, and north of 54° of 1°·8.

The mean reading of the barometer for the month of January at the height of 160 feet above the level of the sea was 29·915 ins., being 0·163 in. above the average of 43 years, 0·180 in. higher than in 1883; 0·270 in. lower than in 1882, and 0·205 in. higher than in 1881.

The mean reading of the barometer for the month of February was 29·744 ins., being 0·048 in. below the average of 43 years; 0·160 in. lower than in 1883, 0·307 in. lower than in 1882, and 0·083 in. higher than in 1881.

The mean reading of the barometer for the month of March was 29·762 ins., being 0·013 in. above the average of 43 years, 0·013 in. higher than in 1883, 0·081 in. lower than in 1882; and 0·034 in. lower than in 1881.

From December to January there was a decrease of pressure at stations south of 51° of 0·082 in.; between 51° and 52° of 0·078 in.; between 52° and 53° of 0·081 in.; between 53° and 54° of 0·150 in. and north of 54° of 0·199 in.

From January to February there was a decrease of pressure at stations south of 51° of 0·269 in.; between 51° and 52° of 0·192 in., between 52° and 53° of 0·137 in., between 53° and 54° of 0·124 in., and north of 54° of 0·056 in.

From February to March there was an increase of pressure at stations south of 51° of 0·040 in., between 51° and 52° of 0·02 in., between 52° and 53° of 0·023 in., between 53° and 54° of 0·044 in., and north of 54° of 0·042 in.

About London the barometric pressure was high till January 22nd, particularly from the 12th to the 21st, the mean excess of daily pressure for these 12 days was 0·62 in., and for 22 days ending on the 22nd was 0·38 in.; during the remainder of the month it was low, particularly on the 26th and 27th days, the defects below the average on the 26th, being 0·94 in., and on the 27th 0·77 in.; for the 10 days ending February 1st, it was 0·37 in. Till February 16th the pressure was alternately in excess, and defect for a few days together. From February 17th to March 12th, with the exception of a few days, when it was about its average value, it was low, the average daily deficiency for these 25 days being 0·22 in. From March 13th to the end of the quarter, the pressure differed but little from its average.

Thunderstorms occurred in January on the 25th at Guernsey, Osborne, Bath, Strathfield Turgiss, Barnet, Lowestoft, Nottingham, Halifax, Stonyhurst, and Bradford.

In February, on the 1st at Plymouth, Totnes, and Torquay; on the 10th at Bolton, Halifax, and Carlisle; on the 11th at Barnet; and on the 21st at Bolton and Stonyhurst.

In March, on the 10th at Rugby; and on the 20th at Bolton.

Thunder was heard but lightning was not seen in January, on the 2nd at Stonyhurst; on the 11th at Bolton; on the 25th at Truro; and on the 26th at Truro and Torquay.

In February, on the 10th at Barnet; and on the 25th at Royston and Cambridge.

Lightning was seen but thunder was not heard in January, on the 20th at Halifax and Stonyhurst; on the 21st at Stonyhurst; on the 25th at Bath, Barnet, Oxford, Cambridge, Somerleyton, and Wolverhampton; on the 26th at Plymouth, Torquay, Osborne, Bath, Strathfield Turgiss, Marlborough, Whitchurch, Blackheath, Barnet, Oxford, Royston, Cardington, Cambridge, Rugby, Somerleyton, Wolverhampton, Leicester, Burslem, and Bolton; on the 27th at Guernsey, Plymouth, Torquay, Blackheath, Barnet, Royston, Cambridge, Wolverhampton, and Leicester; on the 28th at Leicester; and on the 29th at Barnet.

In February, on the 13th at Leicester; on the 21st at Torquay, Burslem, and Carlisle; on the 22nd at Torquay; on the 26th and 27th at Totnes.

In March, on the 20th at Liverpool.

Solar halos were seen in January, on the 5th and 9th at Torquay, and on the 21st at Oxford.

In February, on the 14th at Oxford; on the 22nd at Torquay, Bath, and Oxford; on the 23rd at Oxford and Stonyhurst; on the 25th at Torquay and Oxford; on the 27th at Oxford; and on the 29th at Bath.

In March, on the 1st at Halifax; on the 9th at Torquay, Oxford, Bolton, and Halifax; on the 10th at Bolton; on the 11th at Bath and Halifax; on the 12th at Oxford; on the 14th and 15th at Oxford; on the 17th and 18th at Torquay; on the 23rd at Bath and Halifax; on the 24th and 25th at Torquay, Bath, and Oxford; and on the 30th at Torquay, Bath, and Oxford.

Lunar halos were seen in January, on the 3rd at Cambridge and Rugby; on the 10th at Torquay; and on the 12th at Rugby.

In February, on the 5th at Halifax; on the 6th at Strathfield Turgiss; on the 11th at Oxford; and on the 12th at Leicester.

In March, on the 3rd at Leicester and Burslem; on the 6th at Torquay, Oxford, and Burslem; *on the 7th at Torquay, Salisbury,* Strathfield Turgiss, Marlborough, Oxford, Royston, Cambridge,

(*Continued at the end of the following Table.*)

MONTHLY METEOROLOGICAL TABLE FOR THE QUARTER ENDING MARCH 31st, 1884.

The Observations have been reduced to Mean values by Glaisher's Barometrical and Diurnal Range Tables, and the Hygrometrical results have been deduced from the sixth edition of his Hygrometrical Tables.

Names of Stations and Observers.	Height of Station above Sea Level.	Year 1884.	Pressure of Atmosphere in Month.		Temperature of Air in Month.						Mean Temperature.		Vapour.			Mean Degree of Humidity. Satn. = 100.	Mean Weight of a cubic foot of Air.	Mean Reading of Thermometer.		Wind.					Mean Amount of Ozone.	Mean Amount of Cloud.	Rain.	
								Mean						In a cubic foot of Air.							Relative Proportion of							
		Months.	Mean.	Range.	Highest.	Lowest.	Range.	Of all Highest.	Of all Lowest.	Daily Range.	Air.	Dew Point.	Elastic Force.	Mean.	Short of Saturation.			Maximum in Rays of Sun.	Minimum on Grass.	Estimated Strength.	N.	E.	S.	W.			Number of Days it fell.	Amount collected.
	feet.		in.	in.	°	°	°	°	°	°	°	°	in.	grs.	gr.		grs.	°	°									
GUERNSEY, Adolphus Collenette, Esq., F. R. Met. Soc.	270	Jan.	29·897	1·605	52·5	34·3	18·2	49·2	42·1	7·1	45·5	43·5	·282	3·3	0·3	93	548	66·0	39·0	1·3	6	4	7	14	4·1	8·2	22	4·51
		Feb.	29·612	1·107	54·6	35·3	19·3	48·2	40·9	7·3	44·1	42·4	·271	3·1	0·2	93	544	75·7	37·7	1·1	2	6	13	8	3·6	7·4	22	2·89
		Mar.	29·646	0·997	60·4	35·5	24·9	50·6	41·4	9·2	45·4	40·7	·253	2·9	0·6	84	544	89·5	36·7	0·9	8	5	12	6	2·3	6·5	15	2·47
TRURO (Cornwall), C. Barham, Esq., M.D., F. R. Met. Soc.	43	Jan.	30·080	1·880	56·0	34·0	22·0	51·8	43·4	8·4	47·4	42·9	·277	3·2	0·5	87	549	—	—	2·6	3	4	10	14	—	8·4	18	3·81
		Feb.	29·793	1·360	55·0	26·0	29·0	50·8	39·9	10·9	44·4	41·2	·259	3·0	0·4	89	548	—	—	2·7	2	8	11	8	—	7·9	21	5·35
		Mar.	29·857	1·020	61·0	30·0	31·0	53·4	40·0	13·4	45·2	40·9	·256	2·9	0·5	85	548	—	—	2·3	3	7	13	8	—	6·6	17	3·76
PLYMOUTH (Devon), J. Merrifield, Esq., LL.D., F.R.A.S., F. R. Met. Soc.	69	Jan.	30·090	1·985	54·7	34·8	19·9	50·4	41·9	8·5	46·7	44·1	·288	3·4	0·4	92	550	—	—	1·6	3	5	7	16	—	9·0	19	3·86
		Feb.	29·806	1·335	53·5	29·0	24·5	49·2	40·2	9·0	44·6	41·3	·260	2·9	0·4	89	547	—	—	1·8	2	10	9	8	—	8·3	21	4·04
		Mar.	29·850	1·021	59·8	32·8	27·0	51·8	40·1	11·7	45·5	41·4	·261	3·0	0·5	86	547	—	—	1·5	6	10	9	6	—	6·8	16	3·41
TOTNES (Devon), T. H. Edmonds, Esq.	107	Jan.	30·092	1·896	55·9	33·2	22·7	49·6	41·6	8·0	45·8	43·5	·272	3·1	0·4	88	551	—	—	3·0	5	1	7	18	—	8·0	21	6·44
		Feb.	29·794	1·342	56·2	25·5	30·7	49·5	39·1	10·4	44·2	41·6	·263	3·0	0·3	91	548	—	—	2·9	3	9	7	10	—	7·5	22	6·06
		Mar.	29·857	1·018	62·4	27·6	34·8	53·1	37·2	15·9	44·9	40·4	·251	2·9	0·5	85	548	—	—	2·3	6	7	9	9	—	6·8	17	4·52
TORQUAY, Babbacombe (Devon), Edwin E. Glyde, Esq., F. R. Met. Soc.	305	Jan.	29·806	2·007	53·0	32·8	20·2	48·9	41·4	7·5	45·1	42·1	·267	2·8	0·4	89	547	70·5	35·6	1·6	3	8	10	15	5·6	7·8	17	4·87
		Feb.	29·543	1·299	51·9	28·1	23·8	47·8	40·0	7·8	43·8	39·9	·246	2·8	0·5	86	544	80·1	33·9	1·8	2	9	12	6	5·7	7·5	20	5·10
		Mar.	29·587	1·128	59·5	31·9	27·6	50·8	40·0	10·8	44·9	39·7	·244	2·8	0·6	83	543	97·2	31·3	1·5	3	7	12	9	4·9	7·2	16	3·18
VENTNOR, (Isle of Wight) (Royal National Hospital for Consumption), Hartley Sagar, Esq.	80	Jan.	30·052	—	53·2	34·0	19·2	49·9	42·0	7·9	45·6	41·9	·268	3·0	0·5	87	551	—	—	1·4	5	2	5	19	6·4	7·7	18	3·61
		Feb.	29·802	1·030	56·0	31·0	25·0	49·5	41·4	8·1	44·6	40·9	·256	2·9	0·5	87	547	—	—	1·4	3	7	9	10	5·9	7·2	16	2·29
		Mar.	29·828	1·024	58·8	34·0	24·8	51·8	41·1	10·7	45·3	40·0	·248	2·9	0·6	82	547	—	—	1·1	8	7	6	10	6·0	6·0	8	1·78
EASTBOURNE, Miss W. L. Hall.	12	Oct.	29·913	1·100	68·0	33·9	34·1	58·0	46·2	11·8	51·4	48·4	·341	3·9	0·4	90	542	96·9	—	0·4	7	5	7	12	—	—	14	2·91
		Nov.	29·740	1·338	57·1	30·6	26·5	51·2	40·1	11·1	45·7	43·0	·289	3·3	0·2	94	545	77·6	—	0·4	8	1	7	14	—	—	20	5·16
		Dec.	30·047	0·914	52·7	26·6	26·1	44·8	37·4	7·4	41·4	38·7	·235	2·8	0·3	90	556	55·2	35·9	0·3	15	1	4	11	—	—	17	1·80
		Jan.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
		Feb.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
		Mar.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
OSBORNE (Isle of Wight), J. R. Mann, Esq.	172	Jan.	29·941	2·008	53·1	31·9	21·2	48·6	39·4	9·2	44·1	42·1	·269	3·1	0·2	95	550	64·4	38·8	0·4	4	2	11	14	—	7·9	16	2·90
		Feb.	29·719	1·086	54·9	27·0	27·9	48·0	38·2	9·8	42·9	40·7	·254	3·0	0·2	92	548	74·3	36·9	0·4	3	5	13	8	—	7·5	18	2·40
		Mar.	29·753	1·198	64·9	29·9	35·0	53·1	37·5	15·6	44·1	41·7	·264	3·0	0·3	91	547	96·4	36·1	0·1	6	7	10	8	—	5·6	9	2·21
BRIGHTON, F. E. Sawyer, Esq., F. R. Met. Soc.	206	Jan.	29·932	2·074	51·0	30·8	20·2	47·0	38·8	8·2	43·0	40·6	·253	2·9	0·3	91	552	—	37·1	0·9	4	3	8	16	—	7·2	20	3·45
		Feb.	29·714	1·111	52·5	29·5	23·0	47·6	39·0	8·6	43·0	39·2	·240	2·8	0·4	89	549	—	37·3	1·2	2	8	10	9	—	7·0	15	1·21
		Mar.	29·573	1·011	58·8	29·5	29·3	50·2	39·2	11·0	44·0	38·5	·234	2·7	0·6	81	545	—	36·9	1·0	7	7	8	9	—	6·3	10	1·58
SOUTHBOURNE, (near) Bournemouth (Hants), T. A. Compton, Esq., M.D., B.A., F. R. Met. Soc.	95	Jan.	30·034	—	55·9	32·3	23·6	48·7	41·1	7·6	44·8	41·1	·258	2·9	0·5	87	551	—	—	2·6	5	3	8	15	—	6·8	18	2·78
		Feb.	29·783	1·050	54·2	28·3	25·9	47·8	39·9	7·9	43·8	39·8	·246	2·8	0·4	86	548	—	—	1·5	1	11	8	9	—	6·4	17	2·87
		Mar.	29·814	1·026	57·1	31·1	26·0	50·2	39·1	11·1	44·2	39·4	·242	2·8	0·5	83	548	—	—	1·1	0	7	8	7	—	5·2	9	2·43
SALISBURY (Wilton House), Wilts, Thomas Challis, Esq.	186	Jan.	29·901	1·980	54·0	28·0	26·0	48·6	36·1	12·7	43·4	40·3	·251	2·9	0·4	95	551	60·9	35·0	1·3	6	2	10	13	—	8·1	23	3·06
		Feb.	29·692	1·194	55·0	26·0	29·0	48·3	34·2	14·1	41·7	38·4	·231	2·7	0·3	89	549	71·1	32·7	1·0	4	6	11	8	—	7·9	22	2·84
		Mar.	29·723	0·972	67·0	25·0	42·0	55·1	32·8	20·3	42·7	39·7	·245	2·8	0·5	88	548	88·0	30·9	1·0	8	6	10	7	—	6·9	21	3·01

Names of Stations and Observers.	Height of Station above Sea Level.	Year 1884. Months.	Pressure of Atmosphere in Month. Mean.	Pressure Range.	Temperature of Air in Month. Highest.	Lowest.	Range.	Mean Of all Highest.	Mean Of all Lowest.	Mean Daily Range.	Mean Temperature. Air.	Dew Point.	Vapour. Elastic Force.	In a Cubic foot of Air. Mean.	Short of Saturation.	Mean Degree of Humidity. Satn. = 100.	Mean Weight of cubic foot of Air.	Mean Reading of Thermometer. Maximum in Rays of Sun.	Minimum on Grass.	Wind. Estimated Strength.	Relative Proportion of N.	E.	S.	W.	Mean Amount of Ozone.	Mean Amount of Cloud.	Rain. Number of Days it fell.	Amount collected.
	feet.		in.	in.	°	°	°	°	°	°	°	°	in.	grs.	gr.		grs.	°	°									in.
BARNSTAPLE (Devon), William Knill, Esq.	43	Jan.	30·073	1·990	56·0	35·0	21·0	50·8	43·6	7·2	47·4	44·0	·288	3·3	0·5	89	549	—	—	1·4	1	1	10	19	—	6·1	19	4·63
		Feb.	29·844	1·250	54·0	29·0	25·0	49·3	39·9	9·4	44·4	41·4	·260	3·0	0·4	89	548	—	—	1·9	3	9	10	7	—	4·7	22	4·45
		Mar.	29·864	0·920	65·5	33·0	32·5	53·8	42·5	11·3	47·5	41·2	·259	3·0	0·8	79	545	—	—	1·1	1	8	9	13	—	3·2	18	3·65
STRATHFIELD TURGISS (Hants), Rev. C. H. Griffith, M.A., F.R. Met. Soc.	197	Jan.	29·899	2·138	56·1	30·4	25·7	48·9	39·0	9·9	44·1	40·6	·253	2·9	0·4	87	550	63·4	32·7	1·9	3	2	8	18	1·2	7·6	20	3·60
		Feb.	29·713	1·142	55·1	27·4	27·7	48·4	36·7	11·7	42·3	38·4	·232	2·9	0·5	87	548	75·8	32·2	1·9	4	7	10	8	1·4	6·9	13	1·91
		Mar.	29·724	1·016	67·2	25·5	41·7	52·0	35·2	16·8	43·2	39·0	·238	2·7	0·5	85	548	89·8	32·5	1·5	5	7	11	8	1·6	6·1	9	1·71
BATH (Somerset), St. Gregory's College, Downside, Rev. T. J. Almond, O.S.B.	596	Jan.	29·441	1·985	52·8	29·9	22·9	46·8	39·0	7·8	42·9	40·5	·253	2·9	0·3	91	543	59·2	35·0	2·0	3	8	9	16	—	8·0	21	5·97
		Feb.	29·222	1·247	52·1	27·1	25·0	45·2	36·6	8·6	40·9	37·8	·227	2·6	0·4	89	511	74·1	33·0	1·6	3	6	11	9	—	7·0	20	3·10
		Mar.	29·251	1·037	62·6	30·0	32·6	48·7	36·7	12·0	42·3	38·3	·232	2·7	0·5	86	540	90·1	32·9	1·3	5	9	10	7	—	7·0	15	4·32
MARLBOROUGH (Wilts), Rev. Thomas A. Preston, M.A., F.R. Met. Soc.	456	Jan.	29·578	2·034	52·9	30·0	22·9	46·8	38·4	8·4	42·6	39·8	·246	2·8	0·3	89	546	62·3	34·5	1·0	3	2	10	16	—	8·0	18	3·57
		Feb.	29·376	1·192	52·3	26·2	26·1	45·7	36·1	9·6	40·6	37·2	·221	2·5	0·4	88	544	73·9	31·9	1·1	2	5	13	9	—	7·3	18	2·62
		Mar.	29·407	1·046	64·3	27·2	37·1	49·7	35·5	14·2	41·9	38·1	·230	2·7	0·4	88	543	88·5	30·0	0·7	3	12	9	7	—	7·2	11	2·57
WHITCHURCH RECTORY (Oxon), (near Reading), Rev. J. Slatter, M.A., F.R. Met. Soc.	150	Jan.	29·981	2·135	54·6	30·8	23·8	47·6	37·5	10·1	42·8	40·7	·254	2·9	0·3	90	553	—	—	1·0	5	4	10	12	—	6·7	11	2·49
		Feb.	29·781	0·997	55·3	26·7	28·6	47·8	36·7	11·1	42·0	39·8	·245	2·8	0·3	92	550	—	—	1·0	3	9	10	7	—	6·0	13	1·77
		Mar.	29·785	1·025	66·0	25·5	40·5	51·5	35·0	16·5	42·9	39·8	·245	2·8	0·4	89	549	—	—	0·8	6	8	7	10	—	6·3	10	1·54
BLACKHEATH (Kent), James Glaisher, Esq., F.R.S.	150	Jan.	29·919	2·108	54·5	31·0	23·5	47·5	38·9	8·6	43·6	40·3	·250	2·8	0·4	88	551	59·0	22·1	0·9	3	1	11	16	—	7·7	16	1·73
		Feb.	29·749	1·095	56·5	29·0	27·5	47·5	36·8	10·7	41·3	38·8	·236	2·8	0·5	92	550	74·6	29·4	1·0	5	8	9	7	—	6·8	11	1·25
		Mar.	29·765	1·029	68·4	27·5	40·9	52·1	38·1	14·0	44·5	39·7	·244	2·9	0·5	83	547	90·4	30·1	0·4	6	10	10	5	—	6·1	8	1·24
ROYAL OBSERVATORY, Greenwich, W. H. M. Christie, M.A., F.R.S., Astronomer Royal.	159	Jan.	29·915	2·057	55·3	31·2	24·1	47·8	39·2	8·6	43·9	40·9	·256	3·0	0·3	89	550	58·1	34·8	—	—	—	—	—	2·9	8·0	15	1·77
		Feb.	29·744	1·050	57·6	27·8	29·8	47·7	36·8	10·9	41·9	37·5	·225	2·6	0·5	85	549	76·9	33·0	—	—	—	—	—	4·4	7·0	13	1·50
		Mar.	29·762	0·995	68·8	27·3	41·5	52·7	37·4	15·3	44·5	38·2	·231	2·7	0·7	79	547	91·7	32·4	—	—	—	—	—	2·7	6·8	11	1·37
CAMDEN SQUARE (London), G. J. Symons, Esq., F.R.S., F.R. Met. Soc.	123	Jan.	29·957	2·044	55·6	32·2	23·4	48·8	39·2	9·6	44·2	40·3	·250	2·9	0·4	86	551	57·1	35·6	—	5	1	5	20	—	7·2	16	2·30
		Feb.	29·784	1·074	56·3	29·8	26·5	48·2	37·2	11·0	42·0	37·5	·225	2·6	0·5	85	550	64·4	33·6	—	3	7	13	6	—	7·1	14	1·40
		Mar.	29·801	1·021	65·0	27·5	40·5	52·7	37·5	15·2	44·5	38·6	·235	2·7	0·6	80	548	79·7	34·1	—	15	6	5	5	—	6·3	7	1·40
BARNET (Gas Works), T. H. Martin, Esq., C.E.	212	Jan.	29·892	1·923	55·5	30·5	25·0	47·8	37·9	9·9	43·2	39·9	·247	2·8	0·4	88	551	—	—	1·0	4	1	4	22	—	8·1	13	2·35
		Feb.	29·716	1·009	56·0	26·0	30·0	47·5	35·3	12·2	41·0	37·6	·225	2·6	0·4	88	550	76·5	31·7	0·9	3	7	7	12	—	7·7	16	1·79
		Mar.	29·738	1·013	67·5	21·0	46·5	52·4	34·2	18·2	42·6	37·5	·225	2·6	0·6	83	549	90·3	30·0	0·4	4	9	7	11	—	6·5	6	1·58
OXFORD (The Observatory), E. J. Stone, Esq., M.A., F.R.S.	210	Jan.	29·842	2·125	54·7	32·0	22·7	48·6	41·1	7·5	44·8	41·2	·260	3·0	0·4	88	548	66·3	36·1	3·4	1	2	12	16	1·2	7·7	17	1·98
		Feb.	29·667	1·120	53·4	29·1	24·3	48·3	38·3	10·0	42·6	38·3	·232	2·6	0·5	85	547	79·7	33·1	3·1	3	7	12	7	1·9	6·9	13	1·47
		Mar.	29·687	1·059	67·0	28·7	38·3	51·4	37·6	13·8	44·3	39·5	·243	2·8	0·5	83	546	93·9	31·7	2·7	5	7	12	7	1·7	6·3	9	1·38
ROYSTON (Hertfordshire), Hale Wortham, Esq., F.R.A.S., F.R. Met. Soc.	269	Jan.	29·828	2·109	54·4	32·1	22·3	47·2	38·9	8·3	43·0	39·7	·244	2·8	0·4	88	550	—	—	—	2	1	11	17	—	7·3	13	1·75
		Feb.	29·644	1·007	54·2	26·1	28·1	47·5	36·1	11·4	41·6	36·9	·219	2·5	0·5	84	548	—	—	—	2	7	12	8	—	6·8	12	0·57
		Mar.	29·669	0·947	67·7	27·2	40·5	51·7	36·3	15·4	43·4	38·2	·230	2·7	0·5	81	546	—	—	—	7	5	12	7	—	6·8	6	0·94
BEDFORD, Cardington, Mr. J. McLaren, Assistant to S. Whitbread, Esq., M.P.	105	Jan.	29·956	2·138	54·4	32·0	22·4	47·5	37·7	9·8	43·0	38·9	·249	2·8	0·4	90	552	49·9	34·8	2·1	2	1	7	21	—	7·6	15	1·85
		Feb.	29·801	1·098	56·6	26·0	30·6	47·8	35·5	12·3	41·3	37·4	·225	2·6	0·5	84	551	62·9	33·2	1·5	8	6	9	11	—	6·6	13	0·66
		Mar.	29·837	1·030	69·4	26·6	42·8	52·9	35·1	17·8	43·2	38·6	·234	2·7	0·5	84	550	76·9	31·5	1·0	4	7	9	11	—	7·5	7	0·89
CAMBRIDGE (Trinity College), J. W. L. Glaisher, Esq., M.A., F.R.S.	40	Jan.	29·995	1·882	56·4	32·0	24·4	48·2	38·4	9·8	43·3	40·1	·248	2·9	0·4	85	553	66·1	32·1	1·5	1	6	17	7	—	7·3	17	1·49
		Feb.	29·830	1·126	56·0	28·0	28·0	47·9	36·1	11·8	41·6	38·7	·236	2·7	0·3	90	552	81·0	30·5	1·0	3	6	12	8	—	6·8	15	0·90
		Mar.	29·862	0·972	71·2	26·0	45·2	53·4	36·0	17·4	43·7	38·5	·233	2·7	0·5	81	550	99·5	29·4	1·1	6	7	9	10	—	6·0	7	0·72
RUGBY (Warwickshire), Stockton, The Rectory, Rev. W. Tuckwell.	289	Jan.	29·701	—	53·1	29·0	24·1	47·0	37·2	9·8	42·7	39·7	·244	2·8	0·3	88	548	—	—	0·7	2	2	14	13	—	8·4	17	2·01
		Feb.	29·556	1·066	54·8	22·0	32·8	47·5	32·7	14·8	40·2	37·2	·222	2·6	0·3	89	548	—	—	0·6	2	7	14	6	—	7·4	15	0·85
		Mar.	29·550	0·954	67·0	25·8	41·2	51·3	34·9	16·4	42·7	38·5	·233	2·6	0·4	86	545	—	—	0·6	6	8	11	6	—	6·9	12	1·44

Names of Stations and Observers.	Height of Station above Sea Level.	Year 1884. Months.	Pressure of Atmosphere in Month. Mean.	Pressure of Atmosphere in Month. Range.	Temperature of Air in Month. Highest.	Temperature of Air in Month. Lowest.	Temperature of Air in Month. Range.	Temperature of Air in Month. Mean Of all Highest.	Temperature of Air in Month. Mean Of all Lowest.	Temperature of Air in Month. Mean Daily Range.	Mean Temperature. Air.	Mean Temperature. Dew Point.	Vapour. Elastic Force.	Vapour. In a cubic foot of Air. Mean.	Vapour. In a cubic foot of Air. Short of Saturation.	Mean Degree of Humidity, Satn. = 100.	Mean Weight of a cubic foot of Air.	Mean Reading of Thermometer. Maximum in Rays of Sun.	Mean Reading of Thermometer. Minimum on Grass.	Wind. Estimated Strength.	Wind. Relative Proportion of N.	Wind. Relative Proportion of E.	Wind. Relative Proportion of S.	Wind. Relative Proportion of W.	Mean Amount of Ozone.	Mean Amount of Cloud.	Rain. Number of Days it fell.	Rain. Amount collected.
	feet.		in.	in.	°	°	°	°	°	°	°	°	in.	grs.	gr.		grs.	°	°									in.
LOWESTOFT (Suffolk), S. H. Miller, Esq., F.R.A.S., F. R. Met. Soc.	89	Jan.	29·920	2·230	56·1	32·5	23·6	46·6	37·6	9·0	42·3	39·6	·242	2·8	0·4	90	552	65·5	34·9	2·7	4	0	5	22	–	6·5	14	1·52
		Feb.	29·820	1·004	54·5	30·0	24·5	46·0	37·2	8·8	41·6	36·9	·220	2·5	0·5	84	551	74·7	33·0	2·2	2	7	10	10	–	6·7	11	0·83
		Mar.	29·816	1·004	62·0	28·0	34·0	48·8	37·5	11·3	43·0	38·2	·230	2·7	0·5	83	550	89·1	33·6	1·8	5	5	10	11	–	7·3	13	0·97
SOMERLEYTON (Suffolk), The Rectory, Rev. C. J. Steward, F. R. Met. Soc.	50	Jan.	29·972	2·172	56·2	32·0	24·2	47·3	37·5	9·8	42·1	39·9	·245	2·8	0·3	92	553	–	–	1·1	3	2	10	16	4·5	7·2	13	1·46
		Feb.	29·864	0·956	53·7	29·0	24·7	46·3	37·3	9·0	41·1	38·4	·232	2·7	0·3	90	553	–	–	1·0	2	6	18	8	4·2	7·1	16	1·02
		Mar.	29·869	0·954	65·0	25·2	39·8	50·4	36·3	14·1	42·4	38·7	·235	2·7	0·5	87	551	–	–	1·0	6	8	11	6	4·5	6·5	14	1·30
WOLVERHAMPTON (Staffordshire), Wrottesley, E. Simpson, Esq.	500	Jan.	29·520	–	58·9	28·8	25·1	46·7	36·6	10·1	42·0	38·0	·229	2·6	0·4	87	545	–	–	–	2	3	11	15	–	8·7	15	2·73
		Feb.	29·411	1·040	51·8	24·3	27·5	46·0	33·3	12·7	39·4	36·4	·216	2·5	0·4	90	546	–	–	–	1	10	13	5	–	8·7	13	1·54
		Mar.	29·393	0·980	64·8	27·4	37·4	48·7	33·8	14·9	40·7	36·7	·217	2·5	0·4	86	544	–	–	–	3	10	12	6	–	8·7	9	2·51
LEICESTER (Town Museum), J. C. Smith, Esq.	238	Jan.	29·743	2·196	53·6	30·6	23·0	47·5	39·2	8·3	43·5	39·1	·239	2·6	0·5	84	548	59·5	39·0	1·0	2	2	11	16	–	6·7	18	2·01
		Feb.	29·584	1·080	55·2	28·0	27·2	47·3	36·9	10·4	41·5	36·6	·217	2·6	0·5	83	547	71·4	31·1	0·8	2	6	11	10	–	6·2	14	1·09
		Mar.	29·631	1·038	69·3	28·8	40·5	51·8	37·1	14·7	43·8	37·9	·228	2·6	0·6	79	545	87·0	28·3	0·6	6	4	12	9	–	5·8	10	1·39
NOTTINGHAM (Notts), M. O. Tarbotton, Esq., C.E., F.G.S., F. R. Met. Soc.	183	Jan.	29·805	1·988	53·9	31·5	22·4	46·9	37·8	9·1	42·7	39·0	·237	2·7	0·2	86	550	54·2	34·5	0·4	1	5	11	14	1·2	7·9	22	2·05
		Feb.	29·660	1·008	54·5	26·4	28·1	47·3	35·0	12·3	41·0	37·2	·221	2·6	0·4	86	549	64·8	32·0	0·4	2	9	12	6	1·6	6·9	18	1·87
		Mar	29·706	1·056	67·8	29·0	38·8	51·6	35·8	15·8	42·8	33·0	·229	2·6	0·5	83	548	81·6	33·3	0·3	6	10	9	6	1·1	7·8	19	1·13
HOLKHAM (Norfolk), John Davidson, Esq., Assistant to the Earl of Leicester.	39	Jan.	29·936	1·650	54·3	28·6	25·7	46·3	34·6	11·7	41·7	38·1	·229	2·6	0·3	88	553	48·5	29·7	1·8	1	1	19	10	–	7·0	12	1·85
		Feb.	29·838	0·960	54·7	22·3	32·4	46·5	32·5	14·0	40·0	37·5	·224	2·6	0·4	91	553	58·1	27·2	1·4	3	4	20	2	–	6·3	8	0·50
		Mar.	29·869	1·040	67·1	20·4	46·7	49·9	32·9	17·0	41·7	39·0	·239	2·7	0·3	91	552	79·2	26·8	1·0	9	6	13	3	–	6·9	10	1·00
BURSLEM, J. E. Worth, Esq., C.E., F. R. Met. Soc.	556	Jan.	29·382	2·292	52·5	29·9	22·6	45·8	37·8	8·0	41·9	38·9	·239	2·8	0·3	90	543	–	35·9	1·3	3	3	11	14	–	8·0	22	2·61
		Feb.	29·226	1·165	50·4	26·5	23·9	44·3	35·2	9·1	39·6	35·9	·211	2·4	0·4	87	542	–	32·8	1·0	2	8	12	7	–	7·5	20	1·97
		Mar	29·270	1·032	64·6	30·3	34·3	48·1	36·1	12·0	41·5	37·2	·223	2·6	0·5	86	541	–	33·0	0·8	2	8	15	6	–	7·4	15	2·06
LLANDUDNO (Carnarvonshire), James Nicol, Esq., M.D.	100	Jan.	29·842	2·328	57·0	32·2	24·8	48·8	41·1	7·7	45·4	40·4	·251	2·9	0·4	84	547	–	–	1·3	0	1	6	24	–	7·1	19	4·52
		Feb.	29·670	1·280	57·0	32·2	24·8	46·9	38·2	8·7	42·8	37·5	·225	2·6	0·6	82	547	–	–	1·2	2	6	11	10	–	7·5	19	2·98
		Mar.	29·732	1·090	67·5	30·0	37·5	49·6	39·7	9·9	44·5	38·4	·233	2·7	0·7	79	546	–	–	0·9	1	6	12	12	–	7·8	12	2·12
LIVERPOOL, The Observatory, John Hartnup, Esq., F.R.A.S.	197	Jan.	29·738	2·244	54·0	32·5	21·5	47·3	40·4	6·9	43·9	38·6	·235	2·7	0·6	82	547	–	–	1·8	0	6	8	17	–	7·9	18	2·65
		Feb.	29·586	1·225	52·7	30·1	22·6	46·1	37·6	8·5	41·2	37·2	·221	2·6	0·4	86	548	–	–	1·5	2	10	11	6	–	7·1	19	2·38
		Mar.	29·645	1·083	65·3	31·0	34·3	48·7	38·2	10·5	42·6	36·4	·219	2·5	0·6	80	547	–	–	1·6	0	14	9	8	–	6·9	14	2·06
BOLTON, Sharples (Lancashire), Rev. T. Mackereth, F.R.A.S., F. R. Met. Soc.	500	Jan.	29·400	2·334	52·1	30·1	22·0	45·7	37·7	8·0	41·8	38·9	·237	2·8	0·3	90	543	47·4	35·8	1·0	2	3	12	14	3·6	8·6	17	6·01
		Feb.	29·281	1·212	49·4	26·5	22·9	44·0	35·0	9·0	39·3	35·7	·209	2·4	0·4	88	544	48·9	33·1	0·9	3	7	11	8	2·3	7·8	20	3·38
		Mar.	29·325	1·062	65·5	29·8	35·7	47·6	35·5	12·1	41·2	36·5	·216	2·5	0·5	84	543	55·4	33·0	0·7	2	8	15	6	2·3	7·7	17	3·46
HALIFAX, Bermerside Observatory (Yorkshire), E. J. Crossley, Esq., F.R.A.S.	530	Jan.	29·423	1·940	51·3	28·0	23·3	44·8	37·4	7·4	41·0	38·0	·229	2·6	0·4	90	545	58·3	35·7	1·6	1	5	11	14	–	8·2	21	5·59
		Feb.	29·307	1·172	52·3	20·3	32·0	44·0	34·5	9·5	38·8	35·3	·206	2·4	0·4	88	545	65·3	32·8	1·0	4	9	9	7	–	7·6	18	4·28
		Mar.	29·340	1·108	68·5	27·0	41·5	49·3	34·3	15·0	40·9	35·9	·211	2·4	0·6	84	543	78·2	30·7	0·7	3	7	12	9	–	7·4	12	1·91
HULL (Yorkshire), The People's Park, Mr. E. Peak.	12	Jan.	29·954	2·340	54·0	31·0	23·0	46·3	37·2	9·1	42·6	37·9	·228	2·6	0·5	85	553	51·0	33·2	1·8	3	2	10	16	–	6·3	18	3·31
		Feb.	29·855	1·240	54·0	28·0	26·0	45·9	34·8	11·1	41·5	35·9	·211	2·5	0·5	81	552	58·1	33·8	1·3	3	5	11	10	–	6·4	15	1·47
		Mar.	29·879	1·070	66·0	27·0	39·0	50·0	35·1	14·9	43·1	37·2	·222	2·6	0·6	79	551	69·9	33·5	1·1	5	6	10	10	–	6·5	16	1·72
STONYHURST (Lancashire), Rev. S. J. Perry, F.R.S., F. R. Met. Soc., F.R.A.S.	363	Jan.	29·560	2·409	52·4	30·2	22·2	46·7	37·6	9·1	42·3	38·4	·232	2·6	0·5	86	546	57·0	36·0	–	2	3	3	23	–	9·0	27	7·52
		Feb.	29·432	1·246	52·0	22·9	29·1	45·8	34·1	11·7	39·9	36·2	·214	2·5	0·4	87	546	73·3	32·3	–	1	8	11	9	–	8·3	20	3·90
		Mar.	29·475	1·066	67·5	28·1	39·4	50·0	35·6	14·4	42·2	37·2	·222	2·6	0·5	83	544	89·0	32·3	–	3	6	14	8	–	8·2	16	2·74
BRADFORD (Yorkshire), J. McLandsborough, Esq., C.E., F.G.S.	366	Jan.	29·555	1·882	53·6	32·0	21·6	46·9	39·1	7·8	43·0	38·8	·236	2·7	0·5	85	545	49·6	–	1·6	6	4	7	14	–	8·7	18	4·82
		Feb.	29·444	1·090	52·6	26·9	25·7	45·4	36·9	8·5	41·0	36·5	·215	2·5	0·5	84	545	52·1	–	1·0	4	7	9	9	–	8·4	20	3·13
		Mar.	29·478	0·990	66·0	30·0	36·0	48·7	37·3	11·4	42·2	35·8	·210	2·5	0·6	79	544	60·0	–	0·9	3	8	11	9	–	7·8	16	1·65

Names of Stations and Observers.	Height of Station above Sea Level.	Year 1884. Months.	Pressure of Atmosphere in Month. Mean.	Pressure of Atmosphere in Month. Range.	Temperature of Air in Month. Highest.	Temperature of Air in Month. Lowest.	Temperature of Air in Month. Range.	Temperature of Air in Month. Mean Of all Highest.	Temperature of Air in Month. Mean Of all Lowest.	Temperature of Air in Month. Mean Daily Range.	Mean Temperature. Air.	Mean Temperature. Dew Point.	Vapour. Elastic Force.	Vapour. In a cubic foot of Air. Mean.	Vapour. In a cubic foot of Air. Short of Saturation.	Mean Degree of Humidity. Satn. = 100.	Mean Weight of a cubic foot of Air.	Mean Reading of Thermometer. Maximum in Rays of Sun.	Mean Reading of Thermometer. Minimum on Grass.	Wind. Estimated Strength.	Wind. Relative Proportion of N.	Wind. Relative Proportion of E.	Wind. Relative Proportion of S.	Wind. Relative Proportion of W.	Mean Amount of Ozone.	Mean Amount of Cloud.	Rain. Number of Days it fell.	Rain. Amount collected.
	feet.		in.	in.	°	°	°	°	°	°	°	°	in.	grs.	gr.		grs.	°	°									in.
LEEDS (Yorkshire), The Philosophical Hall, HENRY CROWTHER, Esq.	137	Jan.	29·780	2·228	55·0	32·0	23·0	48·0	40·4	7·6	44·5	40·5	·252	2·9	0·5	87	547	—	—	1·3	2	5	5	17	—	8·4	18	4·04
		Feb.	29·686	1·164	55·0	28·0	27·0	47·4	37·7	9·7	42·6	38·0	·229	2·6	0·5	84	548	—	—	1·1	3	7	9	10	—	8·7	14	1·94
		Mar.	29·722	1·112	69·0	30·0	39·0	51·3	37·8	13·5	44·0	37·1	·220	2·6	0·7	76	547	—	—	1·1	2	10	8	11	—	7·3	11	1·45
LANCASTER (Southfields), WILLIAM ROPER, Esq.	114	Jan.	29·797	2·424	53·0	32·0	21·0	46·8	39·0	7·8	43·3	40·6	·254	2·9	0·4	91	549	—	—	—	—	—	—	—	—	—	23	5·46
		Feb.	29·649	1·106	52·0	27·0	25·0	46·9	36·1	10·8	41·4	39·1	·240	2·8	0·2	92	548	—	—	—	—	—	—	—	—	—	20	2·24
		Mar.	29·708	1·140	68·0	30·0	38·0	50·3	37·5	12·8	43·2	37·5	·225	2·6	0·6	81	548	—	—	—	—	—	—	—	—	—	18	3·34
SILLOTH (Cumberland), "The Rectory," REV. F. REDFORD, M.A., F.R.A.S., F. R. Met. Soc.	28	Jan.	29·835	2·783	52·9	30·0	22·9	45·5	39·5	6·0	42·6	40·6	·253	2·9	0·3	92	551	62·2	36·7	2·2	2	6	7	16	11·4	7·6	24	6·21
		Feb.	29·742	1·458	52·3	28·0	24·3	45·1	36·8	8·3	40·7	38·4	·233	2·7	0·3	92	551	78·2	33·9	1·9	3	8	11	7	7·7	6·8	20	2·89
		Mar.	29·791	1·172	67·0	29·5	37·5	48·6	37·4	11·2	42·4	39·7	·244	2·8	0·3	91	550	85·7	34·3	1·3	2	12	8	9	7·5	6·4	17	2·78
CARLISLE, Spital (Cumberland), ISAAC CARTMEL, Esq., F. R. Met. Soc	114	Jan.	29·738	2·606	62·8	25·6	37·2	47·4	37·5	9·9	42·6	39·5	·240	2·8	0·4	88	548	51·6	30·5	1·6	3	3	5	20	3·6	8·6	21	5·84
		Feb.	29·663	1·634	52·8	25·0	27·8	46·8	35·3	11·5	40·8	36·0	·212	2·4	0·6	84	549	60·9	27·1	1·1	2	8	7	12	3·8	8·6	14	1·40
		Mar.	29·698	1·170	68·8	26·2	42·6	50·7	35·8	14·9	42·6	37·7	·227	2·6	0·5	84	548	74·3	27·8	1·0	3	11	6	11	3·2	8·2	9	2·14

Second Rain-gauges are placed—

	October.	November.	December.	January.	February.	March.	Total in Quarter.
At Eastbourne, at the height of 160 feet *above the sea*; the amount collected was	3·00 inches.	5·40 inches.	1·43 inches.	inches.	inches.	inches.	inches.
" Beachy Head " 515 " " "	2·88 "	3·73 "	1·22 "	"	"	"	"
" " 495 " " "	2·57 "	3·77 "	1·26 "	"	"	"	"
" Oxford " 22 " *ground* "	1·85 "	2·77 "	0·71 "	1·82 "	1·36 "	1·35 "	4·55 "
" Cardington " 21 " " "	1·61 "	2·66 "	0·78 "	2·00 "	0·70 "	0·95 "	3·65 "
" Nottingham " 39 " " "	2·92 "	2·91 "	1·38 "	1·72 "	1·79 "	0·97 "	4·48 "
" Holkham " 4 " " "	3·37 "	3·37 "	2·00 "	1·70 "	0·51 "	0·98 "	3·19 "

Lunar Halos—continued.

Buralem and Hull . . . on the 9th . . .

Snow—continued.

8

N D,

NAMES OF STATIONS.

Guernsey, Truro, Plymouth, Totnes, Torquay, Ventnor, Osborne, Brighton, Southbourne, Salisbury, Barnstaple, Bath, Strathfield Turgiss, Marlborough, Whitchurch, Blackheath, Royal Observatory, Camden Square, Barnet, Oxford, Royston, Cardington, Cambridge, Rugby, Lowestoft, Somerleyton, Wolverhampton, Leicester, Nottingham, Burslem, Holkham, Llandudno, Liverpool, Bolton, Halifax, Hull, Stonyhurst, Bradford, Leeds, Lancaster, Silloth, Carlisle

H, 1884.

usual preva- / rere low and / average,— / snow fell on / hole it was a / ry prevalent. / wards. The / middle. / e end. The / during the / its average / ll the 9th day / a daily excess / deficiency of / being 13°·2 / 3 days the / une 11th the / om the 12th / it was 3°·0 / n being 2°·1 / the averages / 1883, 1882, / the averages / han in 1882, / the averages / gher than in / average of

The highest temper ...er than the
The lowest temperat ... June it was
The greatest range
The least ranges of
The greatest number ...er than the
The least number of ...d in June it
The greatest falls o
The least falls of ...age, in May

it was 9°·2

... to April is / May to June

51° of 0°·3, / of 1°·3; and

PARALLELS O.

51° of 7°·3,

LATITUDE, &c ...9, and north

51° of 4°·3, / of 4°·5, and

Guernsey - - ...o feet above

Between the latitudes: 50° and 51 ... 51° and 52 ... 52° and 53 ... 53° and 54 ... 54° and 55 ...rs, 0·181 in. / ...ing 0·033 in.

Mean for the Quarter, 50° to 55°: Year ... in 1882, and / ...ing 0·053 in. / ...in 1882, and

Mean Pressure of dry Air reduced to the level of the Sea.	Highest Reading of the Thermometer.	Lowest Reading of the Thermometer.	Range of Temperature in the Quarter.	Mean of all Highest.	Mean of all Lowest.	Mean Monthly Range of Temperature.	Mean Daily Range of Temperature.	Mean Temperature of the Air.	Mean Temperature of the Dew Point.	Mean Elastic Force of Vapour.	Mean Weight of Vapour in a cubic foot of Air.	Mean additional Weight required for saturation.	Mean degree of Humidity.	Mean Weight of a cubic foot of Air.	Mean Reading of Maximum in Rays of Sun.	Mean Reading of Minimum on Grass.	Wind: Mean Estimated Strength.	Wind: Relative Proportion of N.	E.	S.	W.	Mean Amount of Ozone.	Mean Amount of Cloud.	Rain: Number of Days on which it fell.	Rain: Amount collected.
in.	°	°	°	°	°	°	°	°	°	in.	grs	gr.		grs	°	°									in.
9·743	60·4	34·3	26·1	49·3	41·5	20·8	8·8	45·0	42·2	·269	3·1	0·4	90	545	77·1	37·8	1·1	5	5	11	9	3·3	7·4	59	9·87
9·690	61·0	26·0	35·0	52·0	41·1	27·3	10·9	45·7	41·7	·264	3·0	0·5	87	548	—	—	2·3	3	6	11	10	—	7·6	56	12·92
9·722	59·8	29·0	30·8	50·5	40·7	23·8	9·7	45·6	42·3	·270	3·1	0·4	89	548	—	—	1·6	4	8	8	10	—	8·0	56	11·31
9·771	62·4	23·5	38·9	50·7	39·3	29·4	11·4	45·0	41·5	·262	3·0	0·4	88	549	—	—	2·7	5	6	8	12	—	7·4	60	17·02
9·732	59·5	28·1	31·4	49·2	40·5	23·9	8·7	44·6	40·6	·252	2·8	0·5	86	545	82·6	33·6	1·6	3	6	11	10	5·4	7·5	53	13·15
9·727	58·8	31·0	27·8	50·4	41·5	23·0	8·9	45·2	40·9	·257	2·9	0·5	85	548	—	—	1·3	5	5	7	13	6·1	7·0	42	7·68
9·733	64·9	27·0	37·9	49·9	38·4	28·0	11·5	43·7	41·5	·262	3·0	0·2	93	548	78·4	37·3	0·3	4	5	11	10	—	7·0	43	7·51
9·740	58·8	29·5	29·3	48·3	39·0	24·2	9·3	43·3	39·1	·242	2·8	0·4	87	549	—	37·1	1·0	4	6	9	11	—	6·8	45	6·24
9·733	57·1	28·3	28·8	48·9	40·0	25·2	8·9	44·3	40·1	·249	2·8	0·5	85	549	—	—	2·7	5	7	8	8	—	6·1	44	8·08
9·737	67·0	25·0	42·0	50·1	34·4	32·3	15·7	42·6	39·5	·242	2·8	0·3	91	549	73·3	32·9	1·1	6	5	10	9	—	7·4	66	9·81
9·708	65·5	29·0	36·5	51·3	42·0	26·2	9·3	46·4	42·2	·269	3·1	0·6	86	547	—	—	1·5	2	6	10	13	—	4·7	59	12·73
9·730	62·6	27·1	35·5	46·9	37·4	26·8	9·5	42·0	38·9	·237	2·7	0·4	89	541	74·5	33·6	1·6	4	6	10	11	—	7·3	56	13·39
9·753	67·2	25·5	41·7	49·8	37·0	31·7	12·8	43·2	39·3	·241	2·8	0·5	86	549	76·3	32·5	1·8	4	5	10	11	1·4	6·9	42	6·62
9·728	64·3	26·2	38·1	47·4	36·7	28·7	10·7	41·7	38·4	·232	2·7	0·4	88	543	74·9	32·1	0·9	3	6	11	11	—	8·5	47	8·76
9·768	66·0	25·5	40·5	49·0	36·4	31·0	12·6	42·6	40·1	·248	2·8	0·3	90	551	—	—	0·9	5	7	9	10	—	6·2	34	5·80
9·735	68·4	27·5	40·9	49·0	37·9	30·6	11·1	43·1	39·6	·243	2·8	0·5	88	549	74·7	27·2	0·8	5	6	10	9	—	6·9	35	4·22
9·744	68·8	27·3	41·5	49·4	37·8	31·8	11·6	43·4	38·9	·237	2·8	0·5	84	549	75·6	33·4	—	-	-	-	-	3·3	7·3	39	4·64
9·742	68·0	27·5	40·5	49·9	38·0	30·1	11·9	43·6	38·8	·237	2·7	0·5	84	550	67·1	34·4	—	8	5	8	10	—	6·9	37	5·10
9·781	67·5	21·0	46·5	49·2	35·8	33·8	13·4	42·3	38·3	·232	2·7	0·5	86	550	—	—	0·8	4	6	6	15	—	7·4	35	5·72
9·716	67·0	23·7	43·3	49·4	39·0	28·4	10·4	43·9	39·7	·245	2·8	0·5	85	547	80·0	33·6	3·1	3	5	12	10	1·6	7·0	39	4·83
9·776	67·7	26·1	41·6	48·8	37·1	30·3	11·7	42·7	38·3	·231	2·7	0·5	84	548	—	—	—	4	4	12	11	—	7·6	31	3·26
9·744	69·4	26·0	43·4	49·4	36·1	31·9	13·3	42·5	38·3	·236	2·7	0·5	86	551	63·2	33·3	1·5	3	5	8	14	—	7·2	35	3·40
9·707	71·2	26·0	45·2	49·8	36·8	32·5	13·0	42·8	39·1	·239	2·8	0·4	85	552	82·2	30·7	1·2	3	6	13	8	—	6·7	39	3·11
9·690	67·0	22·0	45·0	48·6	34·9	32·7	13·7	41·9	38·5	·233	2·7	0·3	88	547	—	—	0·6	3	6	13	8	—	7·6	44	4·30
9·720	62·0	28·0	34·0	47·1	37·4	27·4	9·7	42·3	38·2	·231	2·7	0·5	86	551	76·4	33·8	2·2	4	4	8	14	—	6·8	38	3·32
29·721	65·0	25·2	39·8	48·0	37·0	29·6	11·0	41·9	39·0	·237	2·7	0·4	90	552	—	—	1·0	4	5	11	10	4·4	6·9	43	3·78
29·775	64·8	24·3	40·5	47·1	34·6	30·0	12·6	40·7	37·0	·221	2·5	0·4	88	545	—	—	—	2	8	12	9	—	8·7	37	6·78
29·688	69·3	28·0	41·3	48·9	37·7	30·2	11·1	42·9	37·9	·228	2·6	0·5	82	547	72·6	32·8	0·8	3	4	11	12	—	6·2	42	4·49
29·698	67·8	26·4	41·4	48·6	36·2	29·8	12·4	42·2	38·1	·229	2·6	0·4	85	549	67·9	33·3	0·4	3	8	11	9	1·3	7·5	39	5·05
29·687	64·6	23·5	34·1	46·1	36·4	23·9	9·7	41·0	37·3	·224	2·6	0·4	88	542	—	33·9	1·0	2	6	13	9	—	7·6	57	6·64
29·698	67·1	20·4	46·7	47·5	33·3	34·9	14·2	41·1	38·2	·231	2·6	0·3	90	553	61·9	27·9	1·4	4	4	17	5	—	6·7	30	3·35
29·623	67·5	30·0	37·5	48·4	39·7	29·0	8·8	44·2	38·8	·236	2·7	0·6	82	547	—	—	1·1	1	4	10	15	—	7·5	50	9·62
29·650	65·3	30·1	35·2	47·4	38·7	25·1	8·6	42·6	37·4	·225	2·6	0·5	83	547	—	—	1·6	1	10	9	10	—	7·3	51	7·09
29·669	65·5	25·5	39·0	45·8	36·1	25·9	9·7	40·8	37·0	·221	2·6	0·4	87	543	50·6	34·1	0·9	2	6	13	9	2·7	8·0	64	12·85
29·730	68·5	20·3	48·2	46·0	35·4	32·8	10·6	40·2	36·4	·215	2·5	0·5	87	544	67·3	33·1	1·1	3	7	11	10	—	7·7	51	11·78
29·689	66·0	27·0	39·0	47·4	35·7	29·3	11·7	42·4	37·0	·220	2·6	0·5	82	552	59·7	33·5	1·4	4	4	10	12	—	6·4	49	6·50
29·665	67·5	22·9	44·6	47·5	35·8	30·2	11·7	41·5	37·8	·223	2·6	0·5	85	545	73·1	33·2	—	2	6	9	13	—	8·5	63	14·16
29·676	66·0	26·9	39·1	47·0	37·8	27·8	9·2	42·1	37·0	·220	2·6	0·5	83	545	53·9	—	1·2	4	8	9	11	—	8·3	54	9·69
29·647	69·0	28·0	41·0	48·9	38·6	29·7	10·3	43·7	38·5	·234	2·7	0·6	82	547	—	—	1·2	2	7	7	13	—	8·1	43	7·43
29·604	68·0	27·0	41·0	48·0	37·5	28·0	10·5	42·6	39·1	·240	2·8	0·4	88	548	—	—	—	-	-	-	-	—	—	61	11·04
29·577	67·0	28·0	39·0	46·4	37·9	28·2	8·5	41·9	39·6	·243	2·8	0·3	92	551	75·4	35·0	1·8	2	9	9	11	8·9	6·9	61	11·88
29·600	68·8	25·0	43·8	48·3	36·2	35·9	12·1	42·0	37·7	·226	2·6	0·5	85	548	62·3	28·5	1·2	3	7	6	14	3·5	8·5	44	9·28

…atures of the air were at Cambridge, 71°·2; at Cardington, 69°·4; and at Leicester, 69°·3.
…ures of the air were at Halifax, 20°·3; at Holkham, 20°·4; and at Barnet, 21°·0.
…of temperature were at Salisbury, 15°·7; at Holkham, 14°·2; and at Rugby, 13°·7.
…temperature were at Silloth, 8°·5; at Liverpool, 8°·6; and at Torquay, 8°·7.
…r of days of rain were at Salisbury, 66; at Bolton 64; and at Stonyhurst 63.
…f days of rain were at Holkham, 30; at Royston, 31; and at Whitchurch, 34.
…f rain were at Totnes, 17°·02 inches; at Stonyhurst, 14·16 inches; at Bath, 13·39 inches.
…ain were at Cambridge, 3·11 inches; at Royston, 3·36 inches; and at Lowestoft, 3·32 inches.

QUARTERLY METEOROLOGICAL TABLE for different PARALLELS of LATITUDE.

NAMES of STATIONS and OBSERVERS.	Mean Pressure of dry Air reduced to the level of the Sea.	Mean of all Highest Readings of the Thermometer.	Mean of all Lowest Readings of the Thermometer.	Mean Range of Temperature in the Quarter.	Mean of all Highest.	Mean of all Lowest.	Mean Monthly Range of Temperature.	Mean Daily Range of Temperature.	Mean Temperature of the Air.	Mean Temperature of the Dew Point.	Mean Elastic Force of Vapour.	Mean Weight of Vapour in a cubic foot of Air.	Mean additional Weight required for saturation.	Mean degree of Humidity.	Mean Weight of a cubic foot of Air.	Mean Reading of Maximum in Rays of Sun.	Mean Reading of Minimum on Grass.	Wind: Mean Estimated Strength.	Wind: Relative Proportion of N.	E.	S.	W.	Mean Amount of Ozone.	Mean Amount of Cloud.	Rain: Mean Number of Days it fell.	Rain: Mean Amount collected.
	in.	°	°	°	°	°	°	°	°	°	in.	grs.	gr.		grs.	°	°									in.
o -	29·743	60·4	34·3	26·1	49·3	41·5	20·8	8·8	45·0	42·2	·269	3·1	0·4	90	545	77·1	37·8	1·1	5	5	11	9	3·3	7·4	59	9·87
o -	29·731	60·3	28·1	32·2	50·0	40·1	26·4	9·9	44·7	41·0	·257	2·9	0·4	87	548	80·5	36·0	1·7	4	6	9	11	5·7	7·2	50	10·49
o -	29·740	66·6	26·4	40·2	49·2	37·5	30·1	11·7	43·2	39·4	·242	2·8	0·5	87	548	74·5	32·5	1·4	4	6	10	11	2·1	7·0	44	7·45
o -	29·718	66·9	25·4	41·5	48·2	36·1	30·6	12·0	42·0	38·2	·231	2·7	0·4	87	549	70·7	32·2	1·1	3	5	12	10	2·9	7·2	41	4·22
o -	29·661	67·0	26·5	40·5	47·4	37·3	28·8	10·1	42·2	37·6	·226	2·6	0·5	84	546	60·9	33·5	1·2	2	6	10	12	—	7·7	54	10·01
o -	29·589	67·9	26·5	41·4	47·3	37·0	32·0	10·3	42·0	38·7	·235	2·7	0·4	89	550	68·9	31·8	1·5	2	8	7	13	6·2	7·7	53	10·65
1881	29·677	58·2	6·8	51·4	42·4	30·8	35·0	11·6	36·1	32·7	·190	2·2	0·3	87	554	66·8	26·6	1·2	7	9	5	9	—	6·9	40	7·65
1882	29·907	60·6	25·6	35·0	48·9	37·6	29·7	11·8	45·1	39·4	·243	2·8	0·4	87	554	71·9	32·7	1·2	3	4	10	14	3·6	7·1	41	6·55
1883	29·699	56·5	19·6	36·9	45·9	34·1	29·4	11·3	39·4	36·0	·214	2·5	0·4	85	552	74·0	29·3	1·3	5	7	8	10	4·2	6·4	48	6·99
1884	29·668	65·8	26·6	39·2	48·4	37·6	29·6	10·8	42·8	39·0	·238	2·7	0·4	87	548	71·1	33·2	1·4	3	6	10	11	4·2	7·4	58	8·58

METEOROLOGY OF ENGLAND,

DURING THE QUARTER ENDING JUNE 30, 1884.

REMARKS ON THE WEATHER DURING THE QUARTER ENDING JUNE 30TH, 1884.

By JAMES GLAISHER, ESQ., F.R.S., *&c.*

The weather in April was moderately warm at the beginning, but cold with an unusual prevalence of E. and N.E. winds after the middle of the month, the barometer readings were low and the temperature of the month was below its average. The rainfall was less than its average,—there were but very few thunderstorms. The nights were frequently frosty, and snow fell on several days at different places.

The weather in May was very dry and rain became very much needed, on the whole it was a fine, dry, and warm month. During the latter half of the month the east wind was very prevalent. The atmospheric pressure was low during the first week and was generally high afterwards. The weather was cold during the first week and at the end of the month, but warm in the middle.

The weather in June was very cold during the first three weeks, and warm at the end. The north wind was unusually prevalent, and the east wind was very frequent. Rain fell during the first half of the month, and very little afterwards. The atmospheric pressure was below its average during the first 9 days of the month, and was generally above afterwards.

About London the mean daily temperature of the air in April was above its average till the 9th day (the 2nd being as much as 12°·3 and the 3rd 11°·1 above their averages), and the mean daily excess of the 9 days was 6°·2; it was below from April 10th to May 8th, the average daily deficiency of these 29 days being 4°·3; from May 9th to the 17th it was warmer (the 11th and 12th being 13°·2 and 11°·9 respectively above their averages), the mean daily excess being 6°·9; for 3 days the deficiency daily was 0°·5, then for 7 days the excess was 3°·0; from May 28th to June 11th the weather was very cold, the average daily deficiency of mean temperature was 5°·0; from the 12th to the 14th it was warmer, being 3°·0 above the average; from the 15th to the 21st it was 3°·0 below the average, and the 9 days at the end of the quarter were warm, their mean being 2°·1 above the average.

The mean temperature of the air for April was 45°·1, being 1°·0 and 2°·0 below the averages of 113 years and 43 years respectively; it was 1°·7, 2°·8, and 0°·8 lower than in 1883, 1882, and 1881 respectively.

The mean temperature of the air for May was 54°·3, being 1°·8 and 1°·6 above the averages of 113 years and 43 years respectively; it was 1°·2 higher than in 1883, 0°·2 lower than in 1882, and 0°·2 higher than in 1881.

The mean temperature of the air for June was 58°·0, being 0°·2 and 0°·9 below the averages of 113 years and 43 years respectively; it was 1°·0 lower than in 1883, 1°·5 higher than in 1882, and 0°·7 lower than in 1881.

The mean temperature for the quarter was 52°·5, being 0°·2 higher than the average of 113 years and 0°·4 lower than the average of 43 years.

The mean high day temperature of the air in April was 54°·3, being 3°·3 lower than the average of 43 years, in May it was 65°·7, being 1°·5 higher than the average, and in June it was 69°·3, being 1°·6 lower than the average.

The mean low night temperature of the air in April was 37°·1, being 2°·0 lower than the average of 43 years; in May it was 43°·8, being 0°·1 higher than the average, and in June it was 49°·1, being 0°·8 lower than the average.

The mean daily range of temperature in April was 1°·3 lower than the average, in May it was 1°·4 higher than the average, and in June it was 0·7 lower than the average.

The mean temperature of the air for April was 0°·6 higher than in March, in May it was 9°·2 higher than in April, and in June it was 3°·7 higher than in May.

(From the preceding 43 years' observations the increase of temperature from March to April is 5°·4, the increase of temperature from April to May is 5°·6, and the increase from May to June is 6°·2.)

From March to April there was an increase of temperature at stations south of 51° of 0°·3, between 51° and 52° of 0°·8, between 52° and 53° of 0°·9, between 53° and 54° of 1°·3; and north of 54° of 1°·7.

From April to May there was an increase of temperature at stations south of 51° of 7°·3, between 51° and 52° of 8°·8, between 52° and 53° of 8°·2, between 53° and 54° of 6°·9, and north of 54° of 5°·3.

From May to June there was an increase of temperature at stations south of 51° of 4°·3, between 51° and 52° of 3°·9, between 52° and 53° of 3°·7, between 53° and 54° of 4°·5, and north of 54° of 6°·4.

The mean reading of the barometer for the month of April at the height of 160 feet above the level of the sea was 29·645 ins., being 0·107 in. below the average of 43 years, 0·181 in. lower than in 1883; 0·043 in. higher than in 1882, and 0·127 in. lower than in 1881.

The mean reading of the barometer for the month of May was 29·824 ins., being 0·033 in. above the average of 43 years; 0·040 in. higher than in 1883, 0·051 in. lower than in 1882, and 0·105 in. lower than in 1881.

The mean reading of the barometer for the month of June was 29·857 ins., being 0·053 in. above the average of 43 years, 0·064 in. higher than in 1883, 0·122 in. higher than in 1882, and 0·051 in. higher than in 1881.

From March to April there was a decrease of pressure at stations south of 51° of 0·120 in.; between 51° and 52° of 0·106 in., between 52° and 53° of 0·086 in., between 53° and 54° of 0·028 in., and north of 54° of 0·012 in.

From April to May there was an increase of pressure at stations south of 51° of 0·209 in., between 51° and 52° of 0·185 in., between 52° and 53° of 0·154 in., between 53° and 54° of 0·112 in., and north of 54° of 0·033 in.

From May to June there was an increase of pressure at stations south of 51° of 0·035 in., between 51° and 52° of 0·045 in., between 52° and 53° of 0·045 in., between 53° and 54° of 0·092 in., and north of 54° of 0·123 in.

1884. Months.	Temperature of Air.			Temperature of Evaporation.		Temperature of Dew Point.		Temperature of Air—Daily Range.		Elastic Force of Vapour.		Weight of Vapour in a Cubic Foot of Air.	
	Mean.	Diff. from average of 113 years.	Diff. from average of 43 years.	Mean.	Diff. from average of 43 years.	Mean.	Diff. from average of 43 years.	Mean.	Diff. from average of 43 years.	Mean.	Diff. from average of 43 years.	Mean.	Diff. from average of 43 years.
	°	°	°	°	°	°	°	°	°	in.	in.	grs.	gr.
April -	45·1	−1·0	−2·0	42·4	−1·5	39·3	−1·2	17·2	−1·3	0·240	−0·013	2·8	−0·1
May -	54·3	+1·8	+1·6	49·6	+0·7	44·9	−0·2	21·9	+1·4	0·298	−0·001	3·4	−0·1
June -	58·0	−0·2	−0·9	54·4	−0·1	51·0	+0·3	20·2	−0·7	0·374	+0·004	4·2	+0·1
Means -	52·5	+0·2	−0·4	48·8	−0·3	45·1	−0·4	19·8	−0·2	0·304	−0·003	3·5	0·0

1884. Months.	Degree of Humidity.		Reading of Barometer.		Weight of a Cubic Foot of Air.		Rain.		Daily Horizontal movement of the Air.	Reading of Thermometer on Grass. Number of Nights it was				
	Mean.	Diff. from average of 43 years.	Mean.	Diff. from average of 43 years.	Mean.	Diff. from average of 43 years.	Amount.	Diff. from average of 68 years.		At or below 30°.	Between 30° and 40°.	Above 40°.	Lowest Reading at Night.	Highest Reading at Night.
			in.	in.	grs.	grs.	in.	in.	Miles.				°	°
Apr. -	80	0	29·645	−0·107	544	+ 1	1·11	−0·64	246	11	16	3	17·9	42·3
May -	71	−8	29·824	+0·033	537	− 4	0·96	−1·10	323	1	23	7	29·3	50·8
June -	78	+ 3	29·857	+0·053	533	+ 1	2·24	+0·24	193	0	11	19	32·2	48·4
Means -	76	− 2	29·775	−0·003	538	− 1	Sum 4·31	Sum −1·50	Mean 254	Sum 12	Sum 50	Sum 29	Lowest 17·9	Highest 50·8

NOTE.—In reading this table it will be borne in mind that the plus sign (+) signifies *above* the average, and that the minus sign (−) signifies *below* the average.

Average duration of the different directions of the wind referred to eight points of the compass, and duration of each direction in each month in the quarter, were as follows:—

Direction of Wind.	April. 1884.	April. Average.	April. Departure from Average.	May. 1884.	May. Average.	May. Departure from Average.	June. 1884.	June. Average.	June. Departure from Average.
	d.	d.	d.	d.	d.	d.	d.	d.	d.
N.W.	3½	2½	+ 1	¾	1½	− ¾	5¼	2¾	+2½
N.	6½	4½	+ 2	0	4¾	−4¾	8½	3¾	+4¾
N.E.	8¾	6½	+ 2¼	2¾	7½	−4¾	2¾	3¾	−1
E.	1¾	3¼	− 1½	9½	2½	+7	4	2¼	+1¾
S.E.	3¾	2¼	+ 1½	¼	1¾	−1½	½	1½	−1
S.	5	2¾	+ 2¼	5¼	2¾	+2½	¾	2¼	−1½
S.W.	1¾	6¼	− 4½	5¾	8¼	−2½	2	10	−8
W.	0	2¾	− 2¾	6¾	2¼	+4½	6¾	4	+2¾

The plus sign (+) denotes excesses over averages; the largest numbers affected with this sign in the month of April are opposite to S. and N.E.; in May to E. and W.; and in June to N., N.W., and W.

The minus sign (−) denotes deficiencies below averages. In April the largest numbers are opposite to S.W. and W.; in May to N. and N.E.; and in June to S.W. and S.

About London the barometric pressure in April was below its average till the 8th day; the mean deficiency was 0·32 in.; from the 9th to the 14th the mean excess was 0·11 in. daily; for 5 days there was a deficiency of 0·02 daily. From April 15th to the 23rd the departures from the averages were very small. From April 24th to May 6th the barometer was low, the average daily deficiency was 0·23 in. From May 7th to the 16th there was an average daily excess of 0·15 in.; for 3 days a deficiency little differing from the average. From May 20th to the end of the month the pressure was in excess, averaging 0·26 in. daily; from June 1st to the 9th the daily deficiency averaged 0·23 in.; from June 10th to the end of the quarter the pressure was

above its average, excepting the 24th, which was slightly below, and the mean daily excess of this period was 0·19 in.

Thunderstorms occurred in April on the 1st at Halifax; on the 2nd at Blackheath, Royston, Cardington, and Bradford; on the 3rd at Barnet, Cambridge, Burslem, Halifax, and Bradford; on the 5th at Lancaster.

In May, on the 4th at Cardington, Cambridge, and Rugby; on the 5th at Osborne, Stratfield Turgis, Whitchurch, Blackheath, Barnet, Oxford, Cambridge; on the 6th at Torquay, Cambridge, Somerleyton; on the 12th at Ventnor, Osborne, Whitchurch, Blackheath, Barnet, Oxford, Royston, Cardington, Cambridge, and Rugby; and on the 24th at Bath.

In June, on the 5th at Blackheath, Barnet, Oxford, Royston, and Burslem; on the 6th at Stratfield Turgis, Rugby; on the 7th at Southbourne, Bath, Oxford, Wolverhampton, Burslem, Bolton, Halifax, Bradford, and Carlisle; on the 8th at Osborne, Bath, and Oxford; on the 28th at Torquay, Osborne, Southbourne, Bath; on the 29th at Guernsey, Ventnor, Bath, Stratfield Turgis, Whitchurch, Oxford, Bedford, Cambridge, and Rugby.

Thunder was heard but lightning was not seen in April, on the 2nd at Whitchurch and Stonyhurst; on the 3rd at Lowestoft, Bolton, and Stonyhurst; on the 5th at Burslem and Halifax; on the 27th at Barnet; on the 28th at Wolverhampton and Burslem.

In May, on the 5th at Royston, Cardington, Rugby, Wolverhampton, and Hull; on the 6th at Hull; on the 12th at Totnes and Torquay; on the 19th at Rugby; on the 24th at Guernsey and Osborne.

In June, on the 2nd at Stratfield Turgis and Silloth; on the 3rd at Silloth; on the 4th at Bath; on the 5th at Stratfield Turgis and Wolverhampton; on the 6th at Royston, Cambridge, and Hull; on the 7th at Cambridge and Stonyhurst; on the 8th at Rugby; on the 28th at Torquay; and on the 29th at Torquay, Stratfield Turgis, and Royston.

Lightning was seen but thunder was not heard in April, on the 2nd at Barnet and Oxford; on the 4th at Oxford; on the 14th at Stonyhurst. In May, on the 3rd at Cambridge; on the 4th at Hull; on the 12th at Torquay and Blackheath; on the 24th at Totnes, Torquay, Marlborough, Whitchurch, Oxford, Burslem, and Halifax; and on the 25th at Guernsey and Truro.

In June, on the 2nd at Oxford; on the 28th at Plymouth, Torquay, Whitchurch, and Royston; on the 29th at Torquay; and on the 30th at Guernsey.

Solar halos were seen in April, on the 4th at Oxford; on the 5th at Halifax; on the 6th at Torquay, Bath, Oxford, Halifax; on the 17th at Torquay, and on the 30th at Hull.

In May on the 1st at Torquay, Bath, and Halifax; on the 3rd at Oxford; on the 5th at Oxford and Stonyhurst; on the 7th at Oxford; on the 15th at Halifax; on the 18th and 19th at Oxford; on the 24th at Torquay and Halifax.

In June, on the 11th at Halifax; on the 15th at Torquay; on the 25th and 26th at Halifax.

Lunar halos were seen in April, on the 3rd at Torquay and Halifax; on the 4th at Hull; on the 5th at Stratfield Turgis; on the 6th at Bath.

In May, on the 8th at Oxford; and on the 9th at Oxford and Cambridge.

In June, on the 6th at Cambridge.

Auroræ boreales were seen in April, on the 24th at Oxford, Cambridge, Halifax, and Stonyhurst.

Snow fell in April, on the 17th at Whitchurch, Oxford, and Cambridge; on the 18th at Halifax, Hull; on the 19th at Bath; on the 20th at Oxford; on the 21st at Bath and Cambridge; and on the 23rd at Lowestoft and Somerleyton.

In May on the 3rd at Halifax; on the 5th at Whitchurch, Blackheath; on the 18th at Carlisle.

Hail fell in April, on the 2nd at Oxford, Royston, Cambridge; on the 3rd at Halifax; on the 5th at Torquay, on the 13th at Royston and Hull; on the 14th at Barnet; on the 17th at Torquay, Bath, Blackheath, Barnet, Cardington, Rugby, Lowestoft; on the 18th at Hull; on the 20th at Cardington; on the 21st at Osborne, Whitchurch, Barnet, and Cardington; on the 22nd at Barnet, Royston, Cambridge, Hull; on the 24th at Blackheath, Royston, Hull; on the 26th at Torquay; on the 27th at Halifax; on the 28th at Rugby; on the 29th at Hull, and on the 30th at Royston and Rugby.

In May, on the 1st at Stonyhurst; on the 2nd at Bolton; on the 3rd at Stratfield Turgis Cardington, Cambridge, Rugby, Bolton, Halifax, and Stonyhurst; on the 4th at Cardington, Rugby, Wolverhampton, Burslem, Bolton, Halifax, Hull, Stonyhurst, Bradford, and Carlisle; on the 5th at Torquay, Ventnor, Osborne, Stratfield Turgis, Whitchurch, Blackheath, Oxford, Royston, Cardington, Cambridge, Rugby, Somerleyton, Wolverhampton, Burslem, Bolton, Halifax, Hull; on the 6th at Cardington, Somerleyton, Halifax, and Hull; and on the 18th and 20th at Carlisle.

In June, on the 6th at Truro, Oxford; on the 7th at Truro, Rugby; on the 8th at Oxford and Halifax; on the 29th at Oxford.

Fog prevailed in April, on the 2nd at Torquay; on the 7th at Bolton; on the 8th at Oxford; on the 9th, 10th, 11th, 13th, and 27th at Bath; on the 29th at Osborne, Bath, Blackheath, Barnet, Cambridge; and on the 30th at Lowestoft.

In May, on the 2nd at Guernsey; on the 7th at Stonyhurst; on the 10th at Totnes, Torquay, and Bath; on the 11th at Guernsey; on the 12th at Guernsey and Bolton; on the 13th at Guernsey and Bath; on the 16th at Guernsey and Ventnor; on the 17th and 20th at Guernsey; on the 25th at Guernsey, Torquay; and on the 27th at Cambridge.

In June, on the 7th at Bath; on the 11th at Guernsey, Torquay, Ventnor, Bath; on the 12th at Guernsey, Bath; on the 17th at Bath; on the 23rd and 24th at Guernsey; on the 25th at Bolton; on the 26th at Guernsey; on the 27th at Ventnor; and on the 28th at Guernsey.

MONTHLY METEOROLOGICAL TABLE FOR THE QUARTER ENDING JUNE 30TH, 1884.

The Observations have been reduced to Mean values by Glaisher's Barometrical and Diurnal Range Tables, and the Hygrometrical results have been deduced from the sixth edition of his Hygrometrical Tables.

Names of Stations and Observers.	Height of Station above Sea Level.	Year 1884. Months.	Pressure of Atmosphere in Month. Mean.	Pressure of Atmosphere in Month. Range.	Temperature of Air in Month. Highest.	Temperature of Air in Month. Lowest.	Temperature of Air in Month. Range.	Temperature of Air in Month. Mean Of all Highest.	Temperature of Air in Month. Mean Of all Lowest.	Temperature of Air in Month. Mean Daily Range.	Mean Temperature. Air.	Mean Temperature. Dew Point.	Vapour. Elastic Force.	Vapour. In a cubic foot of Air. Mean.	Vapour. In a cubic foot of Air. Short of Saturation.	Mean Degree of Humidity. Sat^n. = 100.	Mean Weight of a cubic foot of Air.	Mean Reading of Thermometer. Maximum in Rays of Sun.	Mean Reading of Thermometer. Minimum on Grass.	Wind. Estimated Strength.	Wind. Relative Proportion of N.	E.	S.	W.	Mean Amount of Ozone.	Mean Amount of Cloud.	Rain. Number of Days it fell.	Rain. Amount collected.
	feet.		in.	in.	°	°	°	°	°	°	°	°	in.	grs.	gr.		grs.	°	°									
GUERNSEY, ADOLPHUS COLLENETTE, Esq., F. R. Met. Soc.	270	April	29·505	0·750	56·3	35·5	20·8	51·6	41·3	10·3	45·5	41·2	·239	3·0	0·5	85	541	102·2	37·2	0·9	8	10	6	6	1·2	6·8	19	2·38
		May	29·750	0·826	76·7	40·4	36·3	60·4	48·3	12·1	52·9	47·0	·323	3·7	0·9	85	537	110·9	43·8	0·9	7	9	4	11	2·5	4·6	12	1·00
		June	29·787	0·904	71·4	43·8	27·6	63·1	49·5	13·6	55·0	48·9	·345	3·9	1·0	80	536	114·1	44·5	0·6	11	1	2	16	4·2	5·4	10	3·18
TRURO (Cornwall), C. BARHAM, Esq., M.D., F. R. Met. Soc.	43	April	29·745	0·930	62·0	27·0	35·0	55·7	38·8	16·9	45·0	39·4	·241	2·8	0·8	81	546	—	—	2·4	6	10	11	3	—	5·8	8	1·66
		May	29·953	0·910	76·0	32·0	44·0	62·8	45·6	17·2	51·4	44·7	·297	3·4	0·9	79	542	—	—	2·6	4	8	9	10	—	5·6	9	0·85
		June	29·989	0·800	75·0	40·0	35·0	67·4	49·9	17·5	55·1	52·1	·391	4·4	0·5	90	539	—	—	2·3	12	1	4	13	—	5·7	11	1·68
PLYMOUTH (Devon), J. MERRIFIELD, Esq., LL.D., F.R.A.S., F. R. Met. Soc.	69	April	29·745	0·934	61·0	31·4	29·6	51·1	39·6	13·5	45·7	39·7	·245	2·8	0·7	80	545	—	—	1·2	8	12	6	4	—	6·3	12	1·72
		May	29·937	0·942	74·0	35·5	38·5	59·2	46·3	12·6	51·6	45·4	·304	3·3	0·9	79	542	—	—	1·6	4	10	5	12	—	6·1	10	1·00
		June	29·981	0·788	75·2	42·0	33·2	67·1	51·3	15·8	58·3	51·2	·379	4·3	1·3	76	535	—	—	1·1	11	3	6	10	—	5·7	8	0·73
TOTNES (Devon), T. H. EDMONDS, Esq.	107	April	29·747	1·072	63·3	27·8	35·5	54·8	36·5	18·3	45·2	38·1	·229	2·7	0·9	76	545	—	—	1·9	9	10	5	6	—	5·6	10	2·25
		May	29·941	0·967	74·0	30·8	43·2	62·3	43·3	19·0	52·2	44·9	·290	3·4	1·1	77	541	—	—	2·7	6	9	4	12	—	6·0	11	1·82
		June	29·980	0·776	78·5	38·4	40·1	69·1	47·3	21·8	57·8	46·6	·320	3·6	1·4	73	536	—	—	1·7	15	3	4	8	—	6·6	9	1·10
TORQUAY, Babbacombe (Devon), EDWIN E. GLYDE, Esq., F. R. Met. Soc.	305	April	29·485	1·166	57·5	33·2	24·3	50·7	39·5	11·2	44·4	37·7	·236	2·7	0·7	76	542	109·0	31·3	1·3	10	10	6	4	4·6	6·2	9	2·19
		May	29·696	1·072	72·2	37·1	35·1	59·1	45·5	13·6	51·2	43·9	·287	3·2	1·1	77	548	116·6	38·3	1·4	9	6	5	11	5·5	5·9	10	1·53
		June	29·751	0·784	76·9	41·0	35·9	66·8	50·6	16·2	57·5	48·1	·336	3·8	1·5	75	534	125·5	43·1	1·0	10	5	4	11	3·9	5·3	9	1·48
VENTNOR, (Isle of Wight) (Royal National Hospital for Consumption), HARTLEY SAGAR, Esq.	80	April	29·694	0·728	58·1	32·5	25·6	53·0	40·5	12·5	45·7	38·8	·237	2·7	0·8	78	543	—	—	1·2	6	14	7	3	6·0	6·1	6	1·18
		May	29·912	0·942	73·1	41·5	31·6	61·0	48·1	12·9	53·0	46·0	·310	3·5	1·0	77	540	—	—	1·3	4	12	5	10	6·3	5·0	9	1·12
		June	29·930	0·830	73·2	42·8	30·4	65·5	52·0	13·5	57·0	50·1	·361	4·0	1·2	77	536	—	—	0·9	10	6	6	8	6·0	5·7	7	2·10
EASTBOURNE, Miss W. L. HALL.	12	Jan.	30·083	1·458	53·6	31·8	21·8	48·1	40·2	8·2	44·6	40·4	·252	2·9	0·5	83	553	62·6	37·4	0·2	9	1	4	17	—	—	19	4·28
		Feb.	29·844	0·952	53·5	31·0	22·5	47·9	40·0	7·9	44·0	39·6	·244	2·8	0·5	84	549	81·5	37·4	0·2	3	8	9	9	—	—	15	1·73
		Mar.	29·890	0·950	60·5	27·1	33·4	51·7	38·9	12·8	44·9	41·2	·259	3·0	0·4	84	549	92·5	37·1	0·1	9	3	8	10	—	—	9	1·78
		April	29·729	0·656	60·2	30·3	29·9	53·8	39·1	14·7	45·0	40·0	·247	2·8	0·6	83	546	105·3	35·4	0·3	6	13	9	2	1·2	—	9	2·14
		May	29·930	1·004	77·7	36·7	41·0	63·7	46·0	17·7	53·7	48·2	·337	3·6	0·8	81	539	113·9	42·9	0·4	3	7	7	13	2·4	—	6	0·35
		June	29·932	0·884	77·3	44·4	32·9	66·9	49·7	17·2	57·0	52·8	·399	4·4	0·8	85	536	112·4	47·5	0·2	11	4	6	9	1·3	—	9	1·40
OSBORNE (Isle of Wight), J. R. MANN, Esq.	172	April	29·624	0·716	63·6	30·6	33·0	55·5	37·1	18·4	45·3	41·2	·259	3·0	0·5	86	543	108·4	35·4	—	8	9	6	5	—	6·6	9	1·29
		May	29·818	0·976	78·1	36·2	41·9	65·1	44·6	20·5	53·8	49·3	·351	3·9	0·6	84	537	118·2	42·7	0·1	5	8	10	8	—	5·0	7	1·12
		June	29·852	0·834	80·5	40·9	39·6	70·2	49·9	20·3	57·8	52·5	·395	4·4	0·9	82	533	120·4	48·5	—	9	5	6	10	—	5·2	8	2·52
BRIGHTON, F. E. SAWYER, Esq., F. R. Met. Soc.	206	April	29·587	0·788	60·3	31·0	29·3	52·8	38·9	13·9	44·6	41·4	·260	3·0	0·4	90	544	94·3	37·1	1·1	8	10	7	5	—	6·0	10	1·36
		May	29·802	1·024	73·0	37·5	35·5	62·4	46·4	16·0	56·6	47·7	·332	3·7	1·4	72	534	103·6	40·7	1·4	3	8	9	11	—	5·4	9	0·36
		June	29·813	0·827	79·0	44·5	34·5	66·2	50·5	15·7	57·0	48·5	·341	3·8	1·4	73	534	106·1	45·8	0·9	8	5	6	11	—	6·5	9	1·85
SOUTHBOURNE, (near) Bournemouth (Hants), T. A. COMPTON, Esq., M.D., B.A., F. R. Met. Soc.	95	April	29·699	0·760	56·6	27·4	29·2	50·8	36·8	14·0	43·7	36·7	·218	2·5	0·7	76	547	—	—	1·1	13	9	5	3	—	5·0	13	2·00
		May	29·909	0·978	72·0	36·6	35·4	60·3	44·7	15·6	52·1	43·2	·280	3·2	1·2	72	541	—	—	1·1	8	6	6	10	—	4·4	8	1·03
		June	29·933	0·818	72·9	41·7	31·2	64·5	49·9	14·6	56·3	49·6	·356	3·9	0·9	77	547	—	—	0·9	13	4	7	7	—	5·6	6	2·76
SALISBURY (Wilton House), Wilts, THOMAS CHALLIS, Esq.	186	April	29·609	0·908	63·0	22·0	41·0	55·3	32·8	22·5	43·6	38·6	·233	2·7	0·5	82	545	100·4	31·5	1·0	9	8	6	7	—	6·2	14	1·81
		May	29·794	0·992	84·0	30·0	54·0	65·9	39·8	27·1	52·8	46·0	·311	3·5	1·0	78	538	115·8	—	1·0	4	6	7	14	—	5·6	8	0·92
		June	29·838	0·774	86·0	36·0	50·0	71·8	46·6	25·2	57·0	54·2	·421	4·6	0·6	90	534	119·1	—	1·0	16	6	2	6	—	6·7	7	3·44

Names of Stations and Observers.	Height of Station above Sea Level.	Year 1884. Months.	Pressure of Atmosphere in Month. Mean.	Range.	Temperature of Air in Month. Highest.	Lowest.	Range.	Mean Of all Highest.	Of all Lowest.	Daily Range.	Mean Temperature. Air	Dew Point.	Vapour. Elastic Force.	In a Cubic foot of Air. Mean.	Short of Saturation.	Mean Degree of Humidity. Satn. = 100.	Mean Weight of a cubic foot of Air.	Mean Reading of Thermometer. Maximum in Rays of Sun.	Minimum on Grass.	Wind. Estimated Strength.	Relative Proportion of N.	E.	S.	W.	Mean Amount of Ozone.	Mean Amount of Cloud.	Rain. Number of Days it f l.	Amount collected.
	feet.		in.	in.	°	°	°	°	°	°	°	°	in.	grs.	gr.		grs.	°	°									in.
BARNSTAPLE (Devon), William Knill, Esq.	43	April	29·780	0·900	63·0	37·0	26·0	55·9	42·8	13·1	47·8	40·6	·254	2·9	0·9	77	544	—	—	1·1	8	11	8	3	—	2·9	11	1·55
		May	29·945	0·970	81·0	37·5	43·5	65·9	50·9	15·0	56·8	47·1	·325	3·6	1·5	70	538	—	—	1·2	4	7	10	10	—	2·2	10	1·31
		June	30·044	0·800	82·0	40·0	42·0	69·4	53·7	15·7	59·5	50·2	·363	4·1	1·2	71	535	—	—	1·1	7	2	7	14	—	3·3	8	1·69
BATH (Somerset), St. Gregory's College, Downside, Rev. T. J. Almond, O.S.B.	596	April	29·162	0·843	58·1	26·6	31·5	50·1	36·8	13·3	42·5	37·1	·222	2·6	0·6	83	538	104·1	31·9	1·3	11	7	6	6	—	6·0	12	1·84
		May	29·354	1·032	77·6	35·4	41·7	60·4	42·6	17·8	50·5	43·7	·288	3·4	0·7	79	533	114·7	38·5	1·6	8	5	6	12	—	5·3	11	2·69
		June	29·405	0·767	78·6	40·8	37·8	65·1	48·9	16·2	56·0	49·6	·358	4·0	1·0	79	529	121·4	43·3	1·1	10	3	3	14	—	6·2	10	3·38
STRATFIELD TURGIS (Hants), Rev. C. H. Griffith, M.A., F. R. Met. Soc.	197	April	29·603	0·764	65·9	22·9	43·0	54·2	35·5	18·7	43·9	38·6	·234	2·6	0·6	82	545	97·9	32·5	1·5	8	10	7	5	1·6	6·3	12	1·71
		May	29·800	1·069	82·5	32·4	50·1	65·2	41·8	23·4	52·7	43·9	·287	3·3	1·2	72	538	113·0	37·8	1·5	6	4	8	13	2·1	5·1	8	0·72
		June	29·839	0·771	83·3	33·9	49·4	68·9	47·6	21·3	57·0	50·6	·369	4·1	1·1	79	534	117·4	43·1	0·9	12	2	4	12	2·1	6·4	8	2·61
MARLBOROUGH (Wilts), Rev. Thomas A. Preston, M.A., F. R. Met. Soc.	456	April	29·307	0·790	60·3	23·2	37·3	51·0	35·5	15·5	42·0	35·7	·211	2·4	0·7	77	541	97·7	28·8	0·6	8	13	6	3	—	6·8	13	1·51
		May	29·493	1·064	78·4	33·0	45·4	62·4	42·1	20·3	51·6	43·1	·279	3·1	1·2	73	534	113·7	37·6	1·0	5	9	5	12	—	5·6	11	1·13
		June	29·542	0·770	83·0	35·4	47·6	66·7	48·0	18·7	56·3	49·8	·359	4·1	1·0	79	530	118·2	45·0	0·4	13	5	4	8	—	7·0	10	3·51
BLACKHEATH (Kent), James Glaisher, Esq., F.R.S.	150	April	29·649	0·762	69·0	30·0	39·0	53·7	38·4	15·3	45·1	39·5	·212	2·8	0·6	80	544	97·6	30·9	0·7	12	8	8	2	—	7·1	11	1·12
		May	29·826	1·088	81·0	36·1	44·9	64·7	45·1	19·6	54·1	46·0	·309	3·5	1·2	73	537	119·6	37·4	1·1	2	11	8	11	—	4·7	10	0·93
		June	29·864	0·794	82·0	44·5	37·5	67·2	50·3	16·9	57·6	51·5	·381	4·2	1·1	80	534	105·3	43·1	0·4	12	5	2	11	—	6·5	8	2·11
ROYAL OBSERVATORY, Greenwich, W. H. M. Christie, M.A., F.R.S., Astronomer Royal.	159	April	29·645	0·705	68·7	27·0	41·7	54·3	37·1	17·2	45·1	39·3	·240	2·8	0·6	80	544	104·6	32·2	—	—	—	—	—	3·5	7·5	15	1·11
		May	29·824	1·099	80·5	35·6	44·9	65·7	43·8	21·9	54·3	44·9	·298	3·4	1·4	71	537	120·1	37·1	—	—	—	—	—	4·1	5·5	10	0·96
		June	29·857	0·779	82·6	42·7	39·9	69·3	49·1	20·2	58·0	51·0	·374	4·2	1·1	78	533	119·8	42·2	—	—	—	—	—	2·2	6·7	8	2·24
WHITCHURCH RECTORY (Oxon), (near Reading), Rev. J. Slatter, M.A., F.R. Met. Soc.	150	April	29·669	0·741	65·4	26·0	39·4	54·3	35·5	18·8	44·6	38·3	·231	2·6	0·7	78	535	—	—	1·0	9	13	6	2	—	7·0	17	1·84
		May	29·867	1·025	79·5	31·6	47·9	66·1	40·9	25·2	53·4	44·8	·297	3·4	1·1	73	539	—	—	1·3	3	11	8	9	—	4·9	12	0·61
		June	29·891	0·762	81·9	35·0	46·9	69·0	47·0	22·0	57·9	49·2	·350	3·9	1·5	74	534	—	—	0·9	13	6	3	8	—	6·3	7	2·48
CAMDEN SQUARE (London), G. J. Symons, Esq., F.R.S., F. R. Met. Soc.	123	April	29·689	0·722	68·4	29·9	38·5	54·9	37·8	17·1	45·4	37·5	·224	2·6	0·9	74	545	87·6	34·2	—	14	12	2	2	—	6·4	14	1·02
		May	29·866	1·069	81·3	35·0	46·3	66·3	44·7	21·6	54·2	44·2	·289	3·4	1·3	67	536	102·2	40·9	—	7	14	3	7	—	5·2	11	0·78
		June	29·905	0·790	81·7	40·6	41·1	69·7	50·0	19·7	58·2	49·5	·354	3·9	1·3	73	534	107·3	45·7	—	15	11	0	4	—	6·4	7	2·84
BARNET (Gas Works), T. H. Martin, Esq., C.E.	212	April	29·624	0·706	67·7	21·2	46·5	54·2	34·5	19·7	43·4	38·6	·234	2·7	0·5	84	545	104·4	30·2	0·5	5	17	5	3	—	7·3	10	0·92
		May	29·802	1·077	79·0	30·4	48·6	65·1	41·0	24·1	52·2	45·3	·303	3·4	1·0	78	539	120·9	36·9	0·7	3	11	3	14	—	4·9	10	1·14
		June	29·841	0·764	81·6	34·2	37·4	68·9	46·5	22·4	55·9	50·1	·364	4·1	1·9	82	535	129·8	42·5	0·4	9	10	2	9	—	6·6	7	2·73
OXFORD (The Observatory), E. J. Stone, Esq., M.A., F.R.S.	210	April	29·602	0·725	64·1	27·0	37·1	52·9	38·2	14·7	45·4	39·0	·237	2·7	0·7	78	543	102·6	32·1	2·0	11	9	7	3	3·0	6·6	13	1·71
		May	29·770	1·027	78·6	36·6	42·0	63·5	44·5	19·0	54·1	43·4	·280	3·2	1·5	67	536	113·0	37·3	3·1	6	7	10	8	4·8	5·3	11	0·80
		June	29·815	0·742	79·9	37·8	42·1	66·8	49·8	17·0	58·3	49·7	·358	3·9	1·5	75	532	116·7	44·2	1·9	11	6	3	10	4·4	6·2	7	2·15
ROYSTON (Hertfordshire), Half Wortham, Esq., F.R.A.S., F. R. Met. Soc.	269	April	29·575	0·670	67·4	24·7	42·7	54·4	35·6	18·8	43·3	38·3	·231	2·7	0·6	82	545	—	—	—	12	9	7	2	—	7·1	12	1·00
		May	29·740	1·197	83·0	34·2	48·8	67·5	42·1	25·4	52·7	46·1	·311	3·4	1·0	78	537	—	—	-	6	8	6	11	—	4·8	3	0·44
		June	29·775	0·774	81·5	37·8	43·7	66·6	47·7	18·9	55·6	49·6	·356	4·0	0·9	81	535	—	—	—	12	5	6	7	—	6·0	7	1·27
BEDFORD, Cardington, Mr. J. McLaren, Assistant to S. Whitbread, Esq., M.P.	105	April	29·726	0·790	69·0	22·0	47·0	54·5	35·5	19·0	44·0	37·7	·226	2·6	0·7	76	547	87·6	31·3	0·9	8	12	6	4	—	6·3	16	1·16
		May	29·891	1·150	85·0	31·0	54·0	67·0	41·7	25·3	54·4	43·4	·282	3·2	1·2	69	539	101·0	38·7	2·0	4	8	5	14	—	4·5	7	0·84
		June	29·937	0·740	86·0	36·6	49·4	69·9	47·9	22·0	57·4	50·5	·368	4·1	1·2	78	536	107·8	45·1	0·5	12	7	3	8	—	5·9	7	2·10
CAMBRIDGE (Trinity College), J. W. L. Glaisher, Esq., M.A., F.R.S.	40	April	29·769	0·692	69·5	23·5	46·0	55·2	35·0	20·2	43·9	38·0	·229	2·6	0·7	80	548	112·4	29·1	1·1	10	9	6	5	—	7·0	14	1·22
		May	29·926	1·148	81·2	33·0	48·2	66·4	41·7	24·7	53·0	45·6	·306	3·5	1·0	78	540	132·4	34·8	1·5	5	8	9	9	—	4·5	9	0·84
		June	29·968	0·756	80·9	39·1	41·8	70·0	46·5	23·5	54·3	51·1	·379	4·2	0·9	83	537	136·4	39·9	0·9	6	7	5	12	—	6·0	8	1·34
RUGBY (Warwickshire), Stockton, The Rectory, Rev. W. Tuckwell.	289	April	29·474	0·744	65·0	21·6	43·4	54·0	34·2	19·8	42·8	39·5	·243	2·8	0·5	88	543	—	—	0·6	13	10	4	3	-	7·2	16	1·94
		May	29·623	1·098	78·3	31·0	47·3	61·6	41·8	21·8	52·0	44·5	·293	3·4	1·0	78	536	—	—	0·8	6	8	9	8	—	5·6	11	1·18
		June	29·694	0·706	84·1	35·0	49·1	68·7	46·1	22·6	55·0	48·0	·335	3·8	1·1	77	544	—	—	0·4	10	6	2	12	—	7·0	10	1·26

Names of Stations and Observers.	Height of Station above Sea Level.	Year 1884. Months.	Pressure of Atmosphere in Month. Mean.	Pressure of Atmosphere in Month. Range.	Temperature of Air in Month. Highest.	Temperature of Air in Month. Lowest.	Temperature of Air in Month. Range.	Temperature of Air in Month. Mean. Of all Highest.	Temperature of Air in Month. Mean. Of all Lowest.	Temperature of Air in Month. Mean. Daily Range.	Mean Temperature. Air.	Mean Temperature. Dew Point.	Vapour. Elastic Force.	Vapour. In a cubic foot of Air. Mean.	Vapour. In a cubic foot of Air. Short of Saturation.	Mean Degree of Humidity. Satⁿ. = 100.	Mean Weight of a cubic foot of Air.	Mean Reading of Thermometer. Maximum in Rays of Sun.	Mean Reading of Thermometer. Minimum on Grass.	Wind. Estimated Strength.	Wind. Relative Proportion of N.	Wind. Relative Proportion of E.	Wind. Relative Proportion of S.	Wind. Relative Proportion of W.	Mean Amount of Ozone.	Mean Amount of Cloud.	Rain. Number of Days it fell.	Rain. Amount collected.
	feet.		in.	in.	°	°	°	°	°	°	°	°	in.	grs.	gr.		grs.	°	°									in.
LOWESTOFT (Suffolk), S. H. Miller, Esq., F.R.A.S., F. R. Met. Soc.	89	April	29·721	0·658	60·0	31·3	28·7	49·9	39·3	10·6	44·0	40·5	·253	2·9	0·6	87	547	105·0	34·9	2·2	8	13	6	3	—	7·0	10	1·27
		May	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
		June	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
SOMERLEYTON (Suffolk), The Rectory, Rev. C. J. Steward, F. R. Met. Soc.	50	April	29·772	0·626	61·5	30·0	31·5	51·2	38·4	12·8	43·5	38·8	·136	2·8	0·5	83	548	—	—	1·0	9	12	6	3	4·4	6·3	15	1·17
		May	29·957	1·154	72·0	33·6	38·4	60·1	44·4	15·7	50·8	44·9	·298	3·4	0·8	85	543	—	—	1·0	7	8	7	9	4·4	5·0	7	1·23
		June	29·963	0·748	75·6	40·0	35·6	62·5	44·6	17·9	52·4	47·6	·330	3·7	0·7	84	541	—	—	1·0	9	9	6	6	4·3	5·3	7	0·79
WOLVERHAMPTON (Staffordshire), Wrottesley, E. Simpson, Esq.	500	April	29·318	0·850	61·5	25·0	36·5	51·4	35·1	16·3	42·3	35·4	·208	2·5	0·8	78	541	—	—	—	11	11	6	2	—	7·9	12	1·61
		May	29·470	1·164	78·0	31·6	46·4	61·2	41·2	20·0	50·1	40·0	·245	2·8	1·3	68	536	—	—	—	4	9	9	9	—	6·7	11	1·10
		June	29·530	0·694	81·5	37·6	43·9	65·2	46·0	19·2	54·3	44·8	·297	3·4	1·4	68	532	—	—	—	11	4	4	11	—	7·2	9	2·05
LEICESTER (Town Museum), J. C. Smith, Esq.	238	April	29·561	0·819	67·5	26·2	41·3	58·1	38·1	15·0	44·7	38·2	·231	2·6	0·7	78	543	99·7	30·0	0·5	10	10	7	3	—	6·8	20	1·86
		May	29·704	1·216	80·0	34·9	45·1	63·4	43·4	20·0	52·7	42·9	·277	3·1	1·5	69	537	108·0	34·5	0·8	7	6	8	10	—	4·8	18	1·24
		June	29·771	0·762	83·0	33·6	49·4	68·1	48·0	20·1	57·4	50·5	·368	4·1	1·2	78	533	112·7	39·3	0·4	11	7	5	7	—	6·6	12	1·86
NOTTINGHAM (Notts), M. O. Tarbotton, Esq., C.E., F.G.S., F. R. Met. Soc.	183	April	29·627	0·786	66·2	25·1	41·1	53·8	37·2	16·6	44·4	37·3	·222	2·6	0·7	75	545	85·7	35·5	0·3	6	18	6	0	1·2	7·5	10	1·76
		May	29·765	1·236	80·1	31·3	48·8	66·2	43·1	23·1	52·6	43·3	·280	3·2	1·3	70	538	105·3	40·1	0·4	2	11	10	8	2·3	5·6	13	0·86
		June	29·823	0·716	85·8	33·9	51·9	70·3	47·2	23·1	56·7	47·8	·334	3·7	1·4	72	534	111·4	44·2	0·2	6	13	6	5	1·2	6·6	11	1·22
HOLKHAM (Norfolk), John Davidson, Esq., Assistant to the Earl of Leicester.	39	April	29·768	0·688	58·0	26·3	41·7	52·3	34·3	18·0	43·5	39·5	·244	2·8	0·5	86	548	112·1	27·1	1·2	14	8	6	2	—	5·7	14	1·41
		May	29·904	1·238	75·4	27·6	47·8	61·2	39·3	21·9	49·8	43·0	·278	3·4	0·9	78	543	124·0	33·8	1·6	9	6	9	7	—	4·7	7	0·80
		June	29·961	0·730	75·8	36·0	39·8	63·9	42·9	21·0	52·4	45·7	·309	3·5	1·0	79	542	136·1	37·0	1·1	16	4	6	4	—	4·7	6	0·50
BURSLEM, J. E. Worth, Esq., C.E., F. R. Met. Soc.	556	April	29·223	0·904	62·2	28·5	33·7	51·6	36·8	14·8	43·2	37·3	·222	2·6	0·6	80	538	—	32·9	0·8	7	13	6	4	—	7·5	16	1·52
		May	29·354	1·248	75·7	34·5	41·2	60·6	42·7	17·9	30·6	42·0	·267	3·1	1·1	73	533	—	38·7	1·1	3	9	10	9	—	5·3	12	1·52
		June	29·443	0·747	79·2	38·3	40·9	66·5	47·3	19·2	55·5	47·3	·328	3·7	1·2	74	529	—	42·9	0·8	10	4	3	13	—	6·3	10	1·90
LLANDUDNO (Carnarvonshire), James Nicol, Esq., M.D.	100	April	29·720	1·070	57·6	31·2	26·4	50·2	39·4	10·8	44·9	38·4	·233	2·7	0·7	78	546	—	—	0·8	6	13	7	14	—	6·1	11	1·19
		May	29·850	1·300	75·2	40·0	35·2	58·7	46·1	12·6	51·7	43·7	·284	3·2	1·0	74	541	—	—	1·0	1	9	6	15	—	5·7	7	1·35
		June	29·942	0·850	81·0	41·5	39·5	63·0	49·9	13·1	55·6	47·5	·330	3·7	1·2	74	538	—	—	0·8	7	2	2	9	—	6·6	6	1·18
LIVERPOOL, The Observatory, John Hartnup, Esq., F.R.A.S.	197	April	29·615	0·790	63·4	30·7	32·7	52·0	39·9	12·1	44·6	37·2	·221	2·5	0·6	72	544	—	—	1·1	8	14	8	0	—	6·0	15	1·23
		May	29·721	1·269	79·2	38·4	40·8	60·0	45·5	14·5	51·0	43·2	·280	3·2	1·0	75	539	—	—	1·9	1	11	7	12	—	5·1	8	1·23
		June	29·831	0·812	81·2	45·9	35·3	63·8	51·1	12·7	56·0	47·1	·326	3·6	1·6	72	535	—	—	1·3	5	3	3	19	—	5·1	8	0·78
BOLTON, Sharples (Lancashire), Rev. T. Mackereth, F.R.A.S., F. R. Met. Soc.	500	April	29·295	0·912	62·8	29·0	33·8	50·8	36·6	14·2	42·8	36·4	·215	2·5	0·7	79	540	66·7	34·6	0·5	8	13	6	3	2·6	6·8	15	0·97
		May	29·407	1·294	76·1	33·9	42·2	59·2	42·3	16·9	49·3	42·1	·269	3·0	0·9	75	535	71·5	40·2	1·0	5	7	8	11	4·1	6·5	11	2·30
		June	29·502	0·752	80·2	38·5	41·7	64·0	47·0	17·0	54·2	45·3	·357	3·9	0·9	80	531	81·3	44·1	0·5	10	5	4	11	3·4	6·3	7	0·78
HALIFAX, Bermerside Observatory (Yorkshire), E. J. Crossley, Esq., F.R.A.S.	530	April	29·305	0·858	62·3	26·5	35·8	51·3	35·5	15·8	41·6	37·1	·222	2·6	0·5	85	542	84·3	33·0	0·5	9	13	5	3	—	7·5	14	2·10
		May	29·408	1·297	79·9	33·0	46·9	61·3	40·5	20·8	50·0	39·1	·241	2·8	1·3	67	535	101·7	37·7	1·2	4	5	11	11	—	5·5	9	1·83
		June	29·510	0·722	81·3	36·5	44·8	65·1	45·0	20·1	53·8	45·5	·304	3·4	1·2	74	532	103·3	42·0	0·6	6	8	7	9	—	6·9	8	1·05
HULL (Yorkshire), The People's Park, Mr. E. Peak.	12	April	29·831	0·780	61·0	26·0	35·0	51·8	36·2	15·6	44·1	36·5	·215	2·5	0·8	74	549	76·3	35·4	1·2	14	9	6	1	—	6·8	21	1·77
		May	29·941	1·288	79·0	33·0	46·0	62·2	41·8	20·4	51·8	44·2	·290	3·3	1·0	85	542	86·3	40·8	1·6	1	5	7	18	—	4·8	12	0·66
		June	30·045	0·710	83·0	34·0	49·0	67·1	45·5	21·6	55·8	47·3	·329	3·7	1·3	73	539	92·9	44·4	0·9	5	5	10	10	—	5·5	6	0·85
STONYHURST (Lancashire), Rev. S. J. Perry, F.R.S., F. R. Met. Soc., F.R.A.S.	353	April	29·457	0·955	68·8	28·0	40·8	54·7	35·5	19·2	44·1	37·0	·219	2·5	0·8	75	542	72·1	32·1	—	9	15	3	3	—	7·8	16	1·01
		May	29·555	1·324	77·9	32·0	45·9	61·1	40·5	20·6	49·5	42·3	·271	3·1	0·8	76	538	112·1	37·0	—	3	6	5	17	—	6·1	13	2·32
		June	29·655	0·741	80·0	39·0	41·0	66·9	45·4	21·5	54·7	46·5	·316	3·5	1·3	73	534	118·7	41·5	—	8	5	1	16	—	7·4	8	1·12
BRADFORD (Yorkshire), J. McLandsborough, Esq., C.E., F.G.S.	366	April	29·489	0·866	61·0	30·4	30·6	51·1	38·5	12·6	43·3	36·5	·216	2·5	0·8	75	542	69·7	—	0·6	10	12	5	3	—	7·8	21	2·09
		May	29·587	1·336	83·9	38·0	45·9	61·8	44·5	17·3	50·8	41·4	·261	3·0	1·2	71	536	79·8	—	1·1	5	7	8	11	—	7·1	14	1·50
		June	29·651	0·701	83·4	40·7	42·7	64·9	48·9	16·0	55·2	46·2	·314	3·6	1·4	72	533	82·1	—	0·4	10	6	5	9	—	7·7	10	1·03

Names of Stations and Observers.	Height of Station above Sea Level.	Year 1884. Months.	Pressure of Atmosphere in Month. Mean.	Pressure of Atmosphere in Month. Range.	Temperature of Air in Month. Highest.	Temperature of Air in Month. Lowest.	Temperature of Air in Month. Range.	Temperature of Air in Month. Mean Of all Highest.	Temperature of Air in Month. Mean Of all Lowest.	Temperature of Air in Month. Mean Daily Range.	Mean Temperature. Air.	Mean Temperature. Dew Point.	Vapour. Elastic Force.	Vapour. In a cubic foot of Air. Mean.	Vapour. In a cubic foot of Air. Short of Saturation.	Mean Degree of Humidity. Satn. = 100.	Mean Weight of a cubic foot of Air.	Mean Reading of Thermometer. Maximum in Rays of Sun.	Mean Reading of Thermometer. Minimum on Grass.	Wind. Estimated Strength	Wind. Relative Proportion of N.	E.	S.	W.	Mean Amount of Ozone.	Mean Amount of Cloud.	Rain. Number of Days it fell.	Rain. Amount collected.
	feet.		in.	in.	°	°	°	°	°	°	°	°	in.	grs.	gr.		grs.	°	°								in.	
LEEDS (Yorkshire), The Philosophical Hall, HENRY CROWTHER, Esq.	137	April	29·675	0·854	67·0	31·0	36·0	53·7	39·4	14·3	45·4	38·1	·230	2·7	0·8	76	544	—	—	1·0	7	15	4	4	—	7·6	19	1·82
		May	29·791	1·292	81·0	37·0	44·0	63·3	45·0	18·3	53·2	39·6	·244	2·8	1·6	60	538	—	—	1·1	3	8	7	13	—	5·9	11	1·12
		June	29·875	0·700	83·0	40·0	43·0	67·5	49·2	18·3	57·5	44·5	·294	3·3	2·1	62	535	—	—	1·0	7	7	3	13	—	6·5	7	0·74
LANCASTER (Southfields), WILLIAM ROPER, Esq.	114	April	29·691	0·992	65·0	30·0	35·0	53·3	37·5	15·8	44·7	42·1	·269	3·0	0·3	91	545	—	—	—	—	—	—	—	—	—	14	1·34
		May	29·805	1·291	75·0	36·7	38·3	59·4	43·0	16·4	50·1	47·8	·333	3·8	0·3	92	541	—	—	—	—	—	—	—	—	—	13	2·65
		June	29·850	0·719	83·0	41·0	42·0	65·1	47·3	17·8	55·2	50·5	·368	4·1	0·8	85	544	—	—	—	—	—	—	—	—	—	8	0·90
SILLOTH (Cumberland), "The Rectory," REV. F. REDFORD, M.A., F.R.A.S., F. R. Met. Soc.	28	April	29·817	1·083	61·6	31·0	30·6	51·3	36·2	15·1	44·2	41·4	·261	3·0	0·4	90	548	101·5	33·5	1·3	6	15	5	4	8·0	6·2	14	1·25
		May	29·870	1·402	73·9	32·0	41·9	58·5	42·6	15·9	49·7	42·9	·277	3·1	1·0	78	543	104·9	38·6	1·8	1	10	6	14	9·6	5·0	14	2·77
		June	29·994	0·805	83·2	39·4	43·8	66·0	47·6	18·4	55·9	47·9	·329	3·7	1·2	75	538	118·6	43·8	1·1	5	8	5	12	6·9	5·8	8	0·46
CARLISLE, Spital (Cumberland), ISAAC CARTMEL, Esq., F. R. Met. Soc	114	April	29·733	1·008	64·6	27·6	39·0	55·1	35·5	19·6	44·2	37·7	·276	2·7	0·7	77	547	88·9	29·8	0·7	5	13	3	9	2·4	7·8	11	1·46
		May	29·766	1·398	78·8	30·8	48·0	60·7	40·5	20·2	49·5	43·1	·279	3·2	1·0	79	541	96·4	36·3	1·0	5	7	5	14	3·0	7·2	12	2·50
		June	29·888	0·782	86·2	35·4	50·8	69·0	46·6	22·4	56·0	49·2	·353	3·9	1·1	78	536	105·6	43·5	0·6	4	6	4	16	2·6	7·9	6	0·36

Second Rain-gauges are placed—

			January.	February.	March.	April.	May.	June	Total in Quarter.
At Eastbourne, at the height of	160 feet	*above the sea*; the amount collected was	3·86 inches	1·85 inches.	2·11 inches.	1·98 inches.	0·87 inches.	1·40 inches.	3·75 inches.
" Beachy Head "	515 "	" "	2·78 "	1·43 "	1·84 "	1·60 "	0·20 "	1·40 "	3·20 "
" " "	495 "	" "	2·85 "	1·46 "	1·84 "	1·86 "	0·27 "	1·44 "	3·57 "
" Oxford "	21 "	*ground* "	— "	— "	— "	1·54 "	0·78 "	2·11 "	4·41 "
" Cardington "	21 "	" "	— "	— "	— "	1·20 "	0·90 "	— "	— "
" Nottingham "	39 "	" "	— "	— "	— "	1·61 "	0·76 "	1·13 "	3·50 "
" Holkham "	4 "	" "	— "	— "	— "	— "	0·80 "	0·50 "	— "

NAMES OF STATIONS.	Mean Pressure of dry Air reduced to the level of the Sea.	Highest Reading of the Thermometer.	Lowest Reading of the Thermometer.	Range of Temperature in the Quarter.	Mean of all Highest.	Mean of all Lowest.	Mean Monthly Range of Temperature.	Mean Daily Range of Temperature.	Mean Temperature of the Air.	Mean Temperature of the Dew Point.	Mean Elastic Force of Vapour.	Mean Weight of Vapour in a cubic foot of Air.	Mean additional Weight required for saturation.	Mean degree of Humidity.	Mean Weight of a cubic foot of Air.	Mean Reading of Maximum in Rays of Sun.	Mean Reading of Minimum on Grass.	WIND. Mean Estimated Strength.	Relative Proportion of N.	E.	S.	W.	Mean Amount of Ozone.
	in.	°	°	°	°	°	°	°	°	°	in.	grs.	gr.		grs.	°	°						
Guernsey - - -	29·594	76·7	35·5	41·2	58·4	46·4	28·2	12·0	51·2	45·7	·309	3·5	0·8	83	538	109·1	41·8	0·8	9	7	4	11	2·6
Truro - - -	29·633	76·0	27·0	49·0	62·0	44·8	38·0	17·2	50·5	45·4	·310	3·5	0·7	80	542	–	–	2·4	7	6	8	9	–
Plymouth - - -	29·654	75·2	31·4	43·8	59·8	45·8	33·8	14·0	51·9	45·4	·309	3·5	1·0	78	541	–	–	1·2	9	8	6	9	–
Totnes - - -	29·723	78·5	27·8	50·7	62·1	42·4	39·6	19·7	51·7	43·5	·283	3·2	1·1	75	541	–	–	2·1	10	11	4	9	–
Torquay - - -	29·695	76·9	33·2	43·7	58·9	45·2	31·8	13·7	51·0	43·2	·282	3·2	1·1	76	541	117·0	37·6	1·2	10	7	5	9	4·7
Ventnor - - -	29·629	73·2	32·5	40·7	59·8	46·9	29·2	12·9	51·9	45·0	·303	3·4	1·1	77	540	–	–	1·1	7	11	6	7	6·1
Eastbourne - -	29·555	77·7	30·3	47·4	61·5	44·9	34·6	16·5	51·9	47·0	·328	3·6	0·7	83	540	110·2	41·9	0·5	7	8	7	8	1·6
Osborne - - -	29·617	80·5	30·6	49·9	63·6	43·9	38·2	19·7	52·3	47·7	·318	3·8	0·7	84	538	115·7	42·2	–	7	7	8	8	–
Brighton - - -	29·757	79·0	31·0	48·0	60·5	45·5	33·1	15·2	52·7	45·9	·311	3·5	1·1	78	537	101·0	41·2	1·1	6	8	7	9	–
Southbourne - -	29·667	72·9	27·4	45·5	58·5	43·8	31·9	14·7	50·7	43·2	·285	3·2	0·9	75	542	–	–	1·0	11	6	6	7	–
Salisbury - - -	29·729	86·0	22·0	64·0	64·7	39·7	48·3	24·9	51·1	46·3	[illegible]	3·6	0·7	83	539	111·8	–	1·0	10	7	5	9	–
Barnstaple - - -	29·663	82·0	37·0	45·0	63·7	49·1	37·2	14·6	54·5	46·0	·314	3·5	1·2	73	539	–	–	1·1	6	7	8	9	–
Bath - - -	29·669	76·6	26·0	52·0	58·5	42·8	37·0	15·7	49·7	43·5	·289	3·3	0·8	80	539	113·4	37·9	1·3	10	5	5	11	–
Stratfield Turgis -	29·665	83·3	22·[illegible]	60·4	62·8	41·6	47·5	21·1	51·2	44·4	·297	3·0	1·0	78	535	109·1	37·8	1·3	9	5	6	10	1·4
Marlborough - -	29·662	83·8	33·2	49·8	60·0	41·9	43·4	18·2	50·0	42·1	·283	3·2	1·0	76	535	109·9	37·1	0·7	9	9	5	8	–
Blackheath - -	29·634	82·0	30·0	52·0	61·9	41·6	40·5	17·3	52·3	45·7	·311	3·5	1·0	78	538	107·5	37·1	0·7	9	8	6	8	–
Royal Observatory -	29·644	82·6	27·0	55·6	63·1	43·3	42·2	19·8	52·5	45·1	·304	3·5	1·0	76	538	114·8	37·2	–	–	–	–	–	3·3
Whitchurch - -	29·681	81·9	26·0	55·9	63·[illegible]	41·1	44·7	22·0	52·0	44·1	·293	3·3	1·1	75	536	–	–	1·1	8	10	6	6	–
Camden Square -	29·665	81·7	29·9	51·8	63·6	44·2	42·0	19·5	52·6	43·7	·289	3·2	1·2	71	538	99·0	40·8	–	12	12	2	4	–
Barnet - - -	29·687	81·6	21·2	60·4	62·7	40·7	44·2	22·1	50·5	44·7	·300	3·4	0·8	81	540	118·4	36·5	0·5	6	13	3	9	–
Oxford - - -	29·666	79·9	27·0	52·9	61·1	44·2	40·4	16·9	52·6	44·0	·294	3·3	1·2	73	537	110·8	37·9	2·5	9	7	7	7	4·1
Royston - - -	29·691	83·0	24·7	58·3	62·8	41·8	45·1	21·0	50·5	44·7	·299	3·4	0·8	80	539	–	–	–	8	7	6	7	–
Cardington - -	29·668	86·0	22·0	64·0	63·8	41·7	50·1	22·1	51·6	45·[illegible]	·292	3·3	1·0	74	541	98·8	38·4	1·1	8	9	5	9	–
Cambridge - -	29·626	81·2	23·5	57·7	63·9	41·1	45·0	22·8	51·1	44·9	·305	3·4	0·9	80	542	127·1	34·6	1·2	7	8	7	9	–
Rugby - - -	29·621	84·1	21·6	62·5	64·1	40·7	46·6	11·4	49·9	44·0	·290	3·3	0·9	81	541	–	–	0·6	10	8	5	8	–
Somerleyton - -	29·665	75·6	30·0	45·6	57·9	42·5	35·2	15·4	48·9	43·8	·288	3·3	0·7	84	544	–	–	1·0	8	10	6	6	4·4
Wolverhampton -	29·733	81·5	25·0	56·5	59·3	40·8	42·3	18·5	48·9	40·1	·251	2·9	1·2	71	536	–	–	–	9	8	6	7	–
Leicester - - -	29·647	83·0	26·2	56·8	61·5	48·2	45·3	18·4	51·6	43·9	·292	3·3	1·1	75	538	106·8	34·6	0·6	9	8	7	7	–
Nottingham - -	29·658	85·8	25·1	60·7	63·4	42·5	47·3	20·9	51·2	42·8	·279	3·2	1·1	72	539	100·8	39·9	0·5	5	14	7	4	1·6
Burslem - - -	29·676	79·2	28·5	50·7	59·6	42·3	38·6	17·3	49·8	42·2	·272	3·1	1·0	76	533	–	[illegible]	0·9	7	9	6	9	–
Holkham - - -	29·644	75·8	26·3	49·5	59·1	38·8	43·1	20·3	48·6	42·7	·277	3·2	0·8	81	544	124·1	32·6	1·3	13	6	7	4	–
Llandudno - -	29·658	81·0	31·9	49·8	57·3	45·1	33·7	12·2	50·7	43·2	·282	3·2	1·0	75	542	–	–	0·9	5	8	5	13	–
Liverpool - - -	29·662	81·2	30·7	50·5	58·6	45·5	36·3	13·1	50·5	45·8	·275	3·1	1·1	73	539	–	–	1·1	5	9	6	10	–
Bolton - - -	29·672	80·2	29·0	51·2	58·0	42·0	39·2	16·0	48·8	42·3	·274	3·1	0·8	78	535	73·2	39·6	0·7	8	8	6	8	3·4
Halifax - - -	29·730	81·3	26·5	54·8	59·2	40·3	42·5	18·9	48·5	40·6	·256	2·9	1·0	75	536	96·4	37·1	0·8	6	9	8	8	–
Hull - - -	29·674	83·0	26·0	57·0	60·4	41·2	43·0	19·2	50·6	42·7	·278	3·2	1·0	77	543	85·1	40·2	1·2	7	6	8	10	–
Stonyhurst - -	29·678	80·0	28·0	52·0	60·9	40·5	42·6	20·4	49·4	41·9	·269	3·0	1·0	75	538	101·0	36·9	–	7	9	3	12	–
Bradford - - -	29·683	83·9	30·4	53·5	59·3	44·0	39·7	15·3	49·8	41·4	·264	3·0	1·1	73	537	77·1	–	0·7	8	8	6	8	–
Leeds - - -	29·674	83·0	31·0	52·0	61·5	44·5	41·0	17·0	52·0	40·7	·256	2·9	1·5	66	539	–	–	1·0	6	10	5	10	–
Lancaster - - -	29·583	83·0	30·0	53·0	59·2	42·6	38·4	16·7	50·0	46·8	·323	3·6	0·5	89	543	–	–	–	–	–	–	–	–
Silloth - - -	29·636	83·2	31·0	52·2	58·6	42·1	48·8	16·5	49·9	44·1	·289	3·2	0·9	81	543	108·3	38·6	1·4	4	11	5	10	8·2
Carlisle - - -	29·654	86·2	27·6	58·6	61·6	40·9	45·9	20·7	48·9	43·5	·286	3·3	0·9	78	541	97·0	36·5	0·8	5	8	4	13	2·7

The highest temperatures of the air were at Carlisle, 86°·2; at Salisbury and Cardington, 86°·0; and at Nottingham, 85°·

The lowest temperatures of the air were at Barnet, 21°·2; at Rugby, 21°·6; and at Salisbury and Cardington, 22°·0.

The greatest ranges of temperature were at Salisbury, 24°·9; at Cambridge, 22°·8; and at Barnet and Cardington, 22°·1.

The least ranges of temperature were at Guernsey, 12°·0; at Llandudno, 12°·2; and at Liverpool, 13°·1.

The greatest number of days of rain were at Leicester and Bradford 45; and at Nottingham 43.

The least number of days of rain were at Ventnor and Royston, 22; and at Eastbourne, Osborne, and Llandudno, 24.

The greatest falls of rain were at Bath, 7·91 inches; at Guernsey, 6·56 inches; and at Salisbury, 6·17 inches.

The least falls of rain were at Royston and Holkham, 2·71 inches; at Somerleyton, 3·19 inches; and at Liverpool, 3·24 inc

QUARTERLY METEOROLOGICAL TABLE for different PARALLELS of LATITUDE.

PARALLELS OF LATITUDE, &c.	Mean Pressure of dry Air reduced to the level of the sea.	Mean of all Highest Readings of the Thermometer.	Mean of all Lowest Readings of the Thermometer.	Mean Range of Temperature in the Quarter.	Mean of all Highest.	Mean of all Lowest.	Mean Monthly Range of Temperature.	Mean Daily Range of Temperature.	Mean Temperature of the Air.	Mean Temperature of the Dew Point.	Mean Elastic Force of Vapour.	Mean Weight of Vapour in a cubic foot of Air.	Mean additional Weight required for saturation.	Mean degree of Humidity.	Mean Weight of a cubic foot of Air.	Mean Reading of Maximum in Rays of Sun.	Mean Reading of Minimum on Grass.	WIND. Mean Estimated Strength.	Relative Proportion of N.	E.	S.	W.	Mean Amount of Ozone.
	in.	°	°	°	°	°	°	°	°	°	in.	grs.	gr.		grs.	°	°						
Guernsey - - - -	29·594	76·7	35·5	41·2	58·4	46·4	28·2	12·0	51·2	45·7	·309	3·5	0·8	83	538	109·1	41·8	0·8	9	7	4	11	2·
Between the latitudes 50° and 51° -	29·659	76·7	30·1	46·6	60·7	44·8	34·5	15·9	51·6	45·3	·305	3·4	0·9	78	540	111·1	40·7	1·3	8	8	6	8	4·
Between the latitudes 51° and 52° -	29·670	82·1	26·6	55·4	62·3	43·0	42·5	19·3	51·7	44·6	·290	3·4	1·0	77	537	110·5	37·7	1·1	9	8	5	8	3·
Between the latitudes 52° and 53° -	29·683	81·5	25·3	56·2	61·3	41·5	43·9	19·8	50·2	43·3	·285	3·2	1·0	77	540	111·5	38·0	0·9	8	9	6	7	3·
Between the latitudes 53° and 54° -	29·668	81·8	29·2	52·6	59·4	42·9	39·6	16·5	50·0	42·6	·275	3·2	1·0	76	539	86·6	38·6	0·9	7	8	6	10	–
Between the latitudes 54° and 55° -	29·635	84·7	29·3	55·4	60·1	41·5	42·4	18·6	49·4	43·7	·287	3·3	0·9	79	542	102·7	37·6	1·1	4	10	5	11	5·
Mean for the Quarter, 50° to 55° Year 1881	29·705	78·6	26·5	51·9	61·0	43·1	41·8	17·9	51·0	43·9	·294	3·3	1·0	77	541	107·2	38·9	1·2	6	9	6	10	4·
" 1882	29·583	73·6	29·9	43·7	60·8	43·9	34·8	16·7	51·1	44·8	·303	3·4	0·9	81	538	108·5	38·6	1·2	5	8	7	10	4·
" 1883	29·673	77·4	28·3	49·1	60·6	42·7	38·6	17·9	50·5	43·7	·289	3·3	0·9	78	539	106·5	37·8	1·1	7	8	7	9	4·
" 1884	29·663	81·4	28·1	53·2	60·8	42·7	40·6	18·0	50·6	43·9	·288	3·5	1·0	77	550	104·5	38·5	1·0	7	8	6	9	3·

METEOROLOGY OF ENGLAND,

DURING THE QUARTER ENDING SEPTEMBER 30, 1884.

Remarks on the Weather during the Quarter ending Sept. 30th, 1884.

By James Glaisher, Esq., F.R.S., *&c.*

The weather in July was warm at the beginning, but cold from the 11th day till near the end of the month, the barometer readings were generally low from the 4th to the 24th, and rain fell frequently between these days; the three preceding months having been dry, the rain was welcome as all the green crops needed it; it exceeded its average for the month at most places, and somewhat retarded the gathering in of hay, and at the end of the month some grass remained uncut.

The weather in August was generally fine and hot, the temperature rose above 90° on different days at different places (see table below); the readings of the barometer were generally above their averages till towards the end of the month, and there was but little rain. The weather was very favourable for harvest work, and the grain crops were gathered in good condition.

The weather in September was generally fine, the temperature low during the first week and high afterwards, particularly about the middle of the month. The reading of the barometer was low during the first week, and generally above its average from the 8th day. The rainfall was small, and the month was favourable for completing the harvest.

About London the mean daily temperature of the air was above its average by 5°·2 till the 10th day of July, excepting the 6th, which was slightly below; from the 11th a cold period set in and continued till the 29th, the mean daily deficiency being 1°·4; for four days the mean excess was 4°·5 daily, then for three days the temperature was slightly below its average; from August 6th to the 24th the mean daily excess was 5°·9, the 8th day being as much as 10°·4, and the 11th 13°·5 above their average values; from August 25th to September 8th the temperature was cold, the mean daily deficiency of these 15 days being 2°·2, and from September 9th to the end of the quarter the mean average excess was 4°·6 daily.

Table showing the Maximum Temperatures at the several Stations on different days between August 1st and the 25th 1884.

Names of Stations.	AUGUST, 1884.															
	1st.	2nd.	6th.	7th.	8th.	9th.	10th.	11th.	12th.	13th.	17th.	18th.	22nd.	23rd.	24th.	25th.
	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°
Guernsey - - -	73·5	67·2	74·4	81·7	80·7	79·4	81·0	80·9	72·0	73·1	72·2	70·4	75·2	78·0	82·5	64·7
Truro - - - -	78·0	70·0	79·0	82·0	75·0	77·0	80·0	80·0	76·0	71·0	76·0	73·0	78·0	82·0	82·0	67·0
Plymouth - - -	77·5	70·5	75·5	78·3	77·1	75·5	79·5	76·0	71·7	72·0	74·0	70·8	76·6	79·0	77·0	70·4
Totnes - - - -	77·3	73·2	74·0	79·5	84·5	75·0	77·0	80·5	72·5	73·4	78·3	74·3	75·6	77·0	80·0	70·2
Torquay - - -	70·7	72·7	69·7	72·7	79·7	73·0	72·8	70·7	70·5	71·5	73·8	74·2	70·4	70·9	71·7	65·8
Ventnor - - -	72·2	71·0	76·6	81·2	79·9	82·3	78·2	83·2	71·0	71·2	76·8	72·8	74·2	74·4	75·9	73·0
Osborne - - -	78·6	77·8	83·1	91·2	85·6	88·6	84·7	91·5	76·7	73·7	85·1	78·2	80·3	81·1	82·6	68·1
Salisbury - - -	85·0	76·0	81·0	89·0	89·0	84·0	85·0	88·0	80·0	80·0	83·0	81·0	83·0	85·0	87·0	65·0
Barnstaple - - -	78·0	83·0	77·0	80·0	87·0	82·0	82·0	84·0	83·0	83·0	79·0	78·0	70·0	71·0	72·0	61·0
Bath - - - -	76·8	67·9	71·9	82·3	85·2	75·0	79·0	82·0	70·1	69·2	71·8	71·0	76·8	79·2	80·1	68·7
Marlborough - -	81·3	71·1	76·3	82·5	87·6	84·7	78·6	85·8	75·9	75·1	80·1	77·4	82·5	82·0	83·8	68·1
Blackheath - - -	80·5	83·5	79·5	84·0	87·0	84·5	82·5	91·0	82·0	77·5	84·5	81·5	81·0	83·0	86·0	67·0
Royal Observatory -	81·1	85·3	79·1	86·8	88·5	87·0	83·1	94·2	84·0	81·9	87·1	84·2	81·3	83·5	88·1	69·3
Whitchurch - - -	76·0	81·5	76·5	77·6	82·3	86·3	84·0	77·0	86·0	85·6	76·0	80·0	76·6	78·5	82·4	83·3
Camden Square - -	79·7	81·6	78·4	86·4	88·4	85·3	82·6	92·0	82·4	79·3	84·6	80·9	80·7	82·6	86·7	67·4
Barnet - - - -	80·0	80·5	78·1	86·5	87·9	86·0	81·0	90·8	81·2	79·0	83·0	81·0	79·0	83·0	85·2	65·5
Oxford - - - -	77·8	79·5	74·6	78·2	85·7	88·1	85·3	86·4	88·8	75·9	77·9	80·4	77·6	81·0	82·4	84·0
Royston - - -	81·1	82·9	76·0	80·3	86·6	92·2	89·2	84·6	90·2	81·1	79·9	84·4	80·2	83·0	84·9	87·3
Cardington - - -	83·4	78·6	83·2	87·0	93·6	88·0	81·0	91·4	80·4	81·0	83·4	82·2	85·0	88·4	88·6	63·0
Cambridge - - -	85·2	80·2	79·2	86·7	90·4	87·9	83·1	91·8	82·0	83·2	85·0	84·5	82·8	85·2	87·6	63·1
Rugby - - - -	75·2	82·9	77·0	82·0	84·5	90·0	86·7	79·0	86·0	75·5	77·0	82·5	74·0	81·8	85·8	85·2
Lowestoft - - -	67·5	79·4	69·8	72·8	70·8	69·8	72·8	75·8	73·6	77·0	73·6	69·0	69·8	71·3	73·4	67·7
Somerleyton - -	70·0	81·8	69·0	73·3	74·0	73·0	77·7	81·8	76·0	79·3	76·8	71·4	72·6	75·0	78·2	64·0
Wolverhampton - -	70·3	79·8	72·4	76·0	77·2	84·8	82·0	80·2	86·7	69·6	74·2	79·9	72·5	78·0	81·2	83·6
Leicester - - -	82·6	75·3	80·6	84·9	90·0	82·8	81·0	90·0	75·0	77·4	83·5	77·3	82·5	85·5	85·6	68·5
Nottingham - - -	81·5	74·4	78·0	81·9	87·5	82·9	79·2	91·1	76·9	78·5	80·8	79·2	78·7	83·0	83·9	65·0
Burslem - - -	77·1	67·4	74·9	78·8	83·0	82·0	79·8	85·8	67·7	73·7	78·3	77·5	77·0	80·0	82·7	63·5
Llandudno - - -	79·3	—	76·0	72·8	80·8	73·5	78·2	76·2	70·1	70·2	71·0	70·1	68·0	76·3	78·0	63·0
Liverpool - - -	69·1	79·0	67·0	75·8	79·1	84·3	71·0	80·0	80·0	69·8	72·0	74·7	70·1	78·6	82·0	84·9
Bolton - - - -	76·9	66·4	73·6	75·9	81·8	80·1	78·1	83·3	70·4	71·5	74·7	74·2	76·0	79·3	82·1	62·3
Halifax - - - -	78·2	70·4	75·4	80·4	84·0	78·0	85·3	89·0	81·3	77·0	80·8	74·2	79·0	86·0	86·0	68·0
Hull - - - -	72·0	77·0	71·0	76·5	76·0	75·0	79·0	81·0	80·0	78·0	79·0	75·0	81·0	78·0	85·0	68·0
Stonyhurst - - -	78·1	66·1	74·1	76·9	81·8	80·0	81·1	84·0	73·1	73·0	75·4	73·2	77·9	80·3	83·4	64·8
Bradford - - -	68·0	76·0	70·6	73·4	75·5	81·6	76·9	79·6	84·4	78·8	72·2	76·2	68·6	74·7	80·5	82·4
Leeds - - - -	80·0	73·0	78·0	82·0	86·0	81·0	83·0	87·0	81·0	79·0	80·0	81·0	78·0	85·0	85·0	68·0
Lancaster - - -	68·0	79·0	70·0	76·0	79·0	83·0	83·0	81·0	79·0	70·0	70·0	73·0	71·0	75·0	81·0	82·0
Silloth - - - -	78·0	67·0	74·9	79·8	84·0	75·4	78·2	79·2	74·7	71·0	72·8	72·2	69·4	74·3	76·3	66·4
Carlisle - - -	70·3	79·8	73·4	78·2	82·6	87·0	82·3	83·5	84·3	80·8	73·8	75·2	73·6	72·3	78·6	83·2

On looking over this table, and also the general tables, it will be seen how great the differences of maximum daily temperatures have been at the different places on the same day; on the 1st the temperature exceeded 85°·0 at Cambridge, whilst at Lowestoft it reached 67°·5, and at Liverpool 69°·1 only; on the 2nd the extremes were at Royal Observatory 85°·3, at Stonyhurst 66°·1; on the 3rd there were many places between Osborne and Wolverhampton with readings of 70°·0 or higher, the highest was 81°·2 at Royston; on this day at Llandudno the highest reading was 62°·5; on the 4th there were several stations between Salisbury and Nottingham with readings exceeding 73°·0, the highest was 76°·0 at Whitchurch, whilst at Bolton the highest reading was 62°·2; on the 5th temperatures exceeding 74°·0 took place at many stations between Truro and Halifax, the highest being 80°·4 at Cambridge, on this day the

C

maximum temperature at Liverpool was 62°·9; on the 6th the extremes were 83°·2 at Cardington and 67°·0 at Liverpool; on the 7th the extremes were 91°·2 at Osborne and 72°·7 at Torquay; on the 8th temperatures exceeding 89°·0 were recorded at several stations between Salisbury and Leicester, the highest was 93°·6 at Cardington, whilst at Lowestoft the highest was 70°·8; on the 9th the extremes were 92°·2 at Royston and 73°·0 at Torquay and Somerleyton; on the 10th the extremes were 89°·9 at Royston and 71°·0 at Liverpool. The most remarkable day is the 11th, the highest temperature was 94°·2 at Greenwich, several stations were above 90°, and many between 85° and 90°, on this day at Torquay the highest temperature was 70°·7. On the 12th extremes were 90°·2 at Royston and 67°·7 at Burslem; on the 13th the extremes were 85°·6 at Whitchurch and 69°·6 at Wolverhampton; on the 14th the highest was 81°·0 at Carlisle, at Llandudno the highest was 65°·2; on the 15th the highest was 81°·0 at Carlisle, and at Liverpool 65°·1. (*Continued on the sixth line from the bottom of the page.*)

1884. Months.	Temperature of — Air. Mean.	Air. Diff. from average of 112 years.	Air. Diff. from average of 43 years.	Evaporation. Mean.	Evaporation. Diff. from average of 43 years.	Dew Point. Mean.	Dew Point. Diff. from average of 43 years.	Air—Daily Range. Mean.	Air—Daily Range. Diff. from average of 43 years.	Elastic Force of Vapour. Mean.	Elastic Force of Vapour. Diff. from average of 43 years.	Weight of Vapour in a Cubic Foot of Air. Mean.	Weight of Vapour. Diff. from average of 43 years.
	°	°	°	°	°	°	°	°	°	in.	in.	grs.	grs.
July -	63·4	+1·7	+1·8	58·5	+0·8	54·4	+0·4	21·8	+0·8	0·424	+0·006	4·7	−1
August	65·3	+4·4	+3·9	59·8	+2·3	54·2	+0·2	25·1	+5·4	0·421	+0·003	4·6	−1
Sept. -	59·3	+2·8	+2·2	56·3	+2·3	53·3	+2·2	17·9	−0·4	0·407	+0·027	4·6	+2
Means -	62·7	+3·0	+2·5	58·2	+1·8	54·0	+0·9	21·6	+1·9	0·417	+0·012	4·6	0

1884. Months.	Degree of Humidity. Mean.	Humidity. Diff. from average of 43 years.	Reading of Barometer. Mean.	Barometer. Diff. from average of 43 years.	Weight of a Cubic Foot of Air. Mean.	Weight. Diff. from average of 43 years.	Rain. Amount.	Rain. Diff. from average of 68 years.	Daily Horizontal movement of the Air.	Reading of Thermometer on Grass. Number of Nights it was At or below 30°.	Between 30° and 40°.	Above 40°.	Lowest Reading at Night.	Highest Reading at Night.
			in.	in.	grs.	grs.	in.	in.	Miles.				°	°
July -	74	− 2	29·780	−0·014	525	− 3	1·77	−0·78	230	0	4	27	30·7	53·8
Aug. -	68	− 9	29·835	+0·058	525	− 3	0·67	−1·74	197	0	5	26	37·1	58·4
Sept. -	81	0	29·835	+0·036	531	− 2	2·09	−0·35	257	0	9	21	32·4	55·5
Means -	74	− 4	29·817	+0·025	527	− 3	Sum 4·53	Sum −2·87	Mean 228	Sum 0	Sum 18	Sum 74	Lowest 30·7	Highest 58·4

Note.—In reading this table it will be borne in mind that the sign (+) signifies *above* the average, and the minus sign (−) signifies *below* the average.

Average duration of the different directions of the wind referred to eight points of the compass, and duration of each direction in each month in the quarter, were as follows:—

Direction of Wind.	July. 1884.	July. Average.	July. Departure from Average.	August. 1884.	August. Average.	August. Departure from Average.	September. 1884.	September. Average.	September. Departure from Average.
	d.	d.	d.	d.	d.	d.	d.	d.	d.
N.W.	7½	2¾	+ 4¾	10¾	2½	+8¼	6	2	+4
N.	½	3¾	− 3¼	0	3½	−3½	1	4¾	−3¾
N.E.	¾	3¾	− 3	3¾	3¼	+ ½	1½	5½	−4
E.	3¼	1½	+ 1¾	3¼	1½	+1¾	9¼	2¼	+7
S.E.	1½	1	+ ½	3½	1½	+2	¾	2	−1¼
S.	6	3	+ 3	½	3¼	−2¾	2	3	−1
S.W.	3½	11	− 7½	4¾	10½	−5¾	8½	8	+ ½
W.	8¼	4¼	+ 4	4¼	4¼	0	2¼	3	− ¾

The plus sign (+) denotes excesses over averages; the largest numbers affected with this sign in the month of July are opposite to N.W. and W.; in August to NW. and S.E.; and in September to E. and N.W.

The minus sign (−) denotes deficiencies below averages. In July the largest numbers are opposite to S.W. and N.; in August to S.W. and N.; and in September to N.E. and N.

On the 16th the extremes were 83°·1 at Greenwich, 81°·9 at Cambridge, 81°·0 at Blackheath; while at Silloth the highest temperature reached was 66°·6, at Torquay 67°·3, at Bradford 70°·4; on the 17th the extremes were 87°·1 at Greenwich, 85°·1 at Osborne, 85°·0 at Cambridge, at Lancaster 70°·0, at Llandudno 71°·0, at Bath 71°·8; on the 18th the highest were 84°·5 at Cambridge, 84°·4 at Royston, 84°·2 at Greenwich; on the 19th the extremes were 81°·2 at Royston, and 63°·0 at Halifax; on the 20th the highest temperature reached 81°·1 at Osborne,

the highest at Liverpool was 64°·3; on the 21st the highest was 83°·6 at Osborne, whilst at Plymouth the highest was 69°·1; on the 22nd the highest was 85°·0 at Cardington, whilst at Llandudno the highest was 68°; on the 23rd the extremes were 85°·5 at Leicester, and 79°·9 at Torquay; on the 24th the extremes were at Cardington 88°·6, and at Torquay 71°·7; on the 25th the highest temperature reached was 87°·3 at Royston, but the highest at Barnstaple reached only 61°·0. After this day there was a great fall in the temperature.

The mean temperature of the air for July was 63°·4, being 1°·7 and 1°·3 above the average of 113 years and 43 years respectively; it was 3°·5 higher than in 1883, 3°·0 higher than in 1882, and 2°·0 lower than in 1881. Back to 1771 there have been nine Julys as warm or warmer than 63°·4.

The mean temperature of the air for August was 65°·3, being 4°·4 and 3°·9 above the averages of 113 years and 43 years respectively; it was 3°·4 higher than in 1883, 5°·7 higher than in 1882, and 6°·2 higher than in 1881. Back to the year 1771 there have been but three Augusts whose mean temperature exceeded 65°·3; the instances were: 1780, when it was 65°·7; 1842, when it was 65°·4; and 1857, when it was 65°·8.

The mean temperature of the air for September was 59°·3, being 2°·8 and 2°·2 above the averages of 113 years and 43 years respectively; it was 2°·5 higher than in 1883, 5°·0 higher than in 1882, and 3°·9 higher than in 1881. Back to the year 1771 there have been 18 Septembers whose mean temperature was equal to or exceeded 59°·3; they were in the years 1779, 1780, 1795, 1804, 1805, 1810, 1815, 1818, 1821, 1823, 1843, 1846, 1857, 1858, 1865, 1868, 1875, and 1880.

The mean temperature for the quarter was 62°·7, being 3°·0 and 2°·5 above the averages of 113 years and 43 years respectively. Back to the year 1771 there have been 6 instances in which the mean temperature of the quarter ending with September has been of the same or of higher temperature than in this year; the instances were: 1779, when it was 63°·2; 1780, when it was 62°·7; 1818, when it was 63°·5; 1857, when it was 63°·3; 1859, when it was 62·8; 1868, when it was 63°·9.

The mean high day temperature of the air in July was 75°·3, being 1°·2 above the average of 43 years, in August it was 78°·7, being 5°·8 above the average, and in September it was 69°·2, being 1°·8 above the average.

The mean low night temperature of the air in July was 53°·5, being 0°·4 above the average of 43 years; in August it was 53°·6, being 0°·4 above the average, and in September it was 51°·3, being 2°·2 above the average.

The mean daily range of temperature in July was 21°·8, being 0°·8 higher than the average; in August it was 25°·1, being 5°·4 higher than the average, and in September it was 17°·9, being 0·4 lower than the average.

The mean temperature of the air for July was 5°·4 higher than in June, in August it was 1°·9 higher than in July, and in September it was 6°·0 lower than in August.

(From the preceding 43 years' observations the increase of temperature from June to July is 3°·2, the decrease from July to August is 0°·7, and the decrease from August to September is 4°·0.)

From June to July there was an increase of temperature at stations south of 51° of 3°·2, between 51° and 52° of 4°·1, between 52° and 53° of 5°·4, between 53° and 54° of 4°·2; and north of 54° of 2°·9.

From July to August there was an increase of temperature at stations south of 51° of 2°·6, between 51° and 52° of 1°·4, between 52° and 53° of 1°·4, between 53° and 54° of 1°·6, and north of 54° of 1°·3.

From August to September there was a decrease of temperature at stations south of 51° of 3°·6, between 51° and 52° of 4°·3, between 52° and 53° of 4°·7, between 53° and 54° of 4°·6, and north of 54° of 4°·4.

The mean reading of the barometer for the month of July at the height of 160 feet above the level of the sea was 29·780 ins., being 0·014 in. below the average of 43 years, 0·092 in. higher than in 1883; 0·080 in. higher than in 1882, and 0·045 in. lower than in 1881.

The mean reading of the barometer for the month of August was 29·835 ins., being 0·053 in. higher than the average of 43 years; 0·006 in. lower than in 1883, 0·005 in. lower than in 1882, 0·159 in. higher than in 1881.

The mean reading of the barometer for the month of September was 29·835 ins., being 0·036 in. higher than the average of 43 years, 0·187 in. higher than in 1883, 0·148 in. higher than in 1882, 0·034 in. higher than in 1881.

From June to July there was a decrease of pressure at stations south of 51° of 0·079 in.; between 51° and 52° of 0·089 in., between 52° and 53° of 0·106 in., between 53° and 54° of 0·139 in., and north of 54° of 0·150 in.

From July to August there was an increase of pressure at stations south of 51° of 0·049 in., between 51° and 52° of 0·054 in., between 52° and 53° of 0·079 in., between 53° and 54° of 0·076 in., and north of 54° of 0·078 in.

From August to September there was an increase of pressure at stations south of 51° of 0·005 in., between 51° and 52° of 0·009 in., between 52° and 53° of 0·003 in., between 53° and 54° of 0·010 in., and north of 54° a decrease of 0·022 in.

About London the barometric pressure was a little above its average in July for the first three days; from the 4th to the 17th it was below, the average daily deficiency being 0·12 in.; from the 18th to the 20th the pressure was 0·13 in. in excess of the daily average; from the 21st to the 24th it was slightly deficient. From July 25th to August 17th the excess daily was 0·13 in., the 18th and 19th days were below; from the 20th to the 26th the excess over the average was 0·11 in. daily. From August 27th to September 7th the mean deficiency equalled 0·34 in. (September 4th being as much as six-tenths below its average), and from September 8th to the end of the quarter the daily excess of atmospheric pressure was 0·14 in.

MONTHLY METEOROLOGICAL TABLE FOR THE QUARTER ENDING SEPTEMBER 30TH, 1884.

The Observations have been reduced to Mean values by Glaisher's Barometrical and Diurnal Range Tables, and the Hygrometrical results have been deduced from the sixth edition of his Hygrometrical Tables.

NAMES of STATIONS and OBSERVERS.	Height of Station above Sea Level.	Year 1884. Months.	Pressure of Atmosphere in Month. Mean.	Pressure of Atmosphere in Month. Range.	Temperature of Air in Month. Highest.	Lowest.	Range.	Mean Of all Highest.	Mean Of all Lowest.	Mean Daily Range.	Mean Temperature. Air.	Mean Temperature. Dew Point.	Vapour. Elastic Force.	Vapour. In a cubic foot of Air. Mean.	Vapour. In a cubic foot of Air. Short of Saturation.	Mean Degree of Humidity. Satn. = 100.	Mean Weight of a cubic foot of Air.	Mean Reading of Thermometer. Maximum in Rays of Sun.	Mean Reading of Thermometer. Minimum on Grass.	Wind. Estimated Strength.	Wind. Relative Proportion of N.	E.	S.	W.	Mean Amount of Ozone.	Mean Amount of Cloud.	Rain. Number of Days it fell.	Rain. Amount collected.
	feet.		in.	in.	°	°	°	°	°	°	°	°	in.	grs.	gr.		grs.	°	°									in.
GUERNSEY, ADOLPHUS COLLENETTE, ESQ., F. R. Met. Soc.	27	July	29·713	0·624	74·3	46·2	28·1	67·3	55·9	11·4	59·9	55·0	·433	4·9	1·0	83	528	117·4	52·4	0·7	1	1	9	20	2·4	6·8	21	3·31
		Aug.	29·754	0·525	82·5	48·8	33·7	69·6	55·4	14·2	63·2	55·2	·439	4·9	1·6	75	526	117·7	49·7	0·7	8	11	4	13	1·7	4·2	10	1·12
		Sept.	29·747	0·785	76·3	47·7	28·6	65·9	55·1	10·8	59·7	55·0	·434	4·9	0·9	85	529	105·3	52·5	0·8	2	9	7	12	1·9	5·7	19	3·33
TRURO (Cornwall), C. BARHAM, ESQ., M.D., F. R. Met. Soc.	43	July	29·855	0·640	80·0	43·0	37·0	69·3	54·1	15·2	59·1	54·0	·418	4·7	0·9	83	532	–	–	2·4	4	1	12	14	–	6·5	16	3·15
		Aug.	29·910	0·527	82·0	42·0	40·0	73·4	53·4	20·0	61·1	53·0	·404	4·4	1·5	75	531	–	–	1·9	5	7	8	11	–	4·8	9	1·64
		Sept.	29·910	0·920	80·0	37·0	43·0	68·8	52·0	16·8	58·5	54·8	·423	4·9	0·8	88	534	–	–	1·8	3	8	9	10	–	6·3	13	1·89
PLYMOUTH (Devon), J. MERRIFIELD, ESQ., LL.D., F.R.A.S., F. R. Met. Soc.	69	July	29·866	0·624	73·0	45·4	27·6	68·1	55·2	12·9	60·6	55·7	·445	5·0	0·9	84	530	–	–	1·4	3	7	8	13	–	7·3	22	3·39
		Aug.	29·914	0·540	79·5	46·4	33·1	72·0	56·2	15·8	63·4	56·4	·457	5·0	1·3	78	528	–	–	1·2	7	11	3	10	–	4·9	10	1·24
		Sept.	29·923	0·887	74·3	40·0	34·3	65·8	53·2	12·6	58·8	54·1	·419	4·7	0·9	84	533	–	–	1·3	8	7	7	8	–	5·6	19	2·52
TOTNES (Devon), T. H. EDMONDS, ESQ.	107	July	29·871	0·622	76·5	43·6	32·9	70·0	52·4	17·6	60·2	55·0	·432	4·9	1·0	83	531	–	–	2·4	5	3	9	14	–	7·0	21	3·46
		Aug.	29·916	0·542	84·5	42·3	42·2	73·0	49·6	23·4	61·5	54·2	·421	4·7	1·1	71	531	–	–	1·8	6	8	3	14	–	4·9	10	1·23
		Sept.	29·929	0·877	77·8	32·4	45·4	67·5	49·9	17·6	58·6	52·2	·391	4·8	1·1	71	534	–	–	2·2	5	7	5	13	–	5·9	18	2·83
TORQUAY, Babbacombe (Devon), EDWIN E. GLYDE, ESQ., F. R. Met. Soc.	305	July	29·653	0·624	73·2	47·0	26·2	67·0	53·9	13·1	59·3	53·7	·412	4·6	1·0	82	528	123·9	46·1	1·2	4	3	13	11	4·2	6·6	22	2·72
		Aug.	29·703	0·605	79·7	46·5	33·2	69·9	54·9	15·0	61·7	51·5	·411	4·6	1·1	76	527	123·4	46·2	1·0	7	11	4	9	3·9	5·4	9	0·77
		Sept.	29·699	1·045	72·9	40·2	32·7	65·1	53·0	12·1	58·4	52·5	·396	4·4	1·1	81	530	116·0	45·8	1·2	7	6	5	12	5·2	5·6	17	1·72
VENTNOR, (Isle of Wight) (Royal National Hospital for Consumption), HARTLEY SAGAR, ESQ.	80	July	29·815	0·598	72·8	48·7	24·1	68·0	56·4	11·6	60·1	55·6	·444	4·9	0·8	85	531	–	–	1·1	2	5	11	13	6·1	6·7	13	1·78
		Aug.	29·909	0·562	83·0	47·5	35·5	72·4	58·6	13·8	62·7	56·3	·457	5·0	1·4	77	528	–	–	1·0	3	10	10	8	4·5	3·1	8	1·13
		Sept.	29·905	0·942	76·1	50·3	25·6	66·7	56·8	9·9	60·6	54·4	·434	4·8	1·1	83	531	–	–	1·1	6	8	5	11	5·4	5·1	16	3·29
OSBORNE (Isle of Wight), J. R. MANN, ESQ.	172	July	29·784	0·576	84·0	44·1	39·9	72·2	54·8	17·4	61·7	57·1	·467	5·2	1·2	85	528	120·7	53·6	0·3	1	3	16	11	–	6·4	14	1·81
		Aug.	29·844	0·562	91·5	43·6	47·9	77·3	55·2	22·1	64·3	57·2	·469	5·1	1·5	76	526	124·0	53·2	0·1	3	9	9	10	–	3·2	8	1·82
		Sept.	29·835	0·912	80·7	45·0	35·7	68·0	53·3	14·7	59·5	56·7	·440	5·2	0·6	91	531	108·8	51·4	0·1	4	8	7	11	–	5·3	17	2·24
BRIGHTON, F. E. SAWYER, ESQ., F. R. Met. Soc.	206	July	29·753	0·611	79·0	45·0	34·0	72·2	56·1	16·1	63·1	53·8	·415	4·8	1·6	75	526	113·9	50·4	0·9	2	3	13	13	–	6·9	18	1·77
		Aug.	29·813	0·571	80·3	46·0	34·3	72·4	56·5	15·9	64·0	54·4	·424	4·7	1·9	71	526	115·8	50·6	0·7	5	5	10	11	–	2·5	6	1·67
		Sept.	29·805	0·945	75·7	46·8	28·9	66·8	54·0	12·8	59·7	55·5	·441	4·7	1·0	84	531	99·0	48·7	1·1	5	7	7	11	–	4·9	16	3·37
SOUTHBOURNE, (near) Bournemouth (Hants), T. A. COMPTON, ESQ., M.D., B.A., F. R. Met. Soc.	95	July	29·847	0·576	72·6	42·7	29·9	66·8	55·1	11·7	59·9	55·1	·433	4·8	1·0	85	531	–	–	1·1	3	4	12	11	–	6·0	17	2·32
		Aug.	29·912	0·522	80·4	44·1	36·3	70·9	53·4	17·5	62·1	53·6	·412	4·5	1·9	74	530	–	–	1·0	5	9	7	10	–	3·8	6	0·95
		Sept.	29·903	0·866	75·3	41·1	34·2	66·0	53·2	12·8	59·1	52·8	·401	4·5	1·1	81	533	–	–	1·3	9	4	6	11	–	5·6	16	2·07
SALISBURY (Wilton House), Wilts, THOMAS CHALLIS, ESQ.	186	July	29·752	1·014	82·0	38·0	44·0	73·3	50·8	22·5	60·7	56·9	·465	5·2	0·8	88	528	122·0	–	1·0	1	2	14	10	–	7·1	22	2·35
		Aug.	29·801	0·572	89·0	39·0	50·0	78·2	47·9	30·3	61·2	57·5	·474	5·2	0·8	88	528	118·2	–	1·1	4	5	13	9	–	4·6	15	1·66
		Sept.	29·816	0·806	83·0	31·0	52·0	69·6	47·3	22·3	58·0	52·7	·399	4·5	0·9	82	533	109·1	–	1·2	4	5	11	10	–	6·2	17	1·19
BARNSTAPLE (Devon), WILLIAM KNILL, ESQ.	43	July	29·901	0·620	80·0	49·0	31·0	71·5	57·9	13·6	63·0	55·2	·437	4·7	1·6	76	529	–	–	1·3	1	2	15	13	–	3·3	19	3·12
		Aug.	29·942	0·590	87·0	43·0	44·0	73·5	56·5	17·0	63·7	54·3	·425	4·6	1·8	72	529	–	–	1·2	2	6	11	12	–	2·3	11	3·40
		Sept.	29·976	0·830	79·0	46·0	33·0	68·7	57·4	11·3	61·7	55·2	·436	4·9	1·5	79	531	–	–	1·1	2	6	12	10	–	3·1	18	2·24

Names of Stations and Observers.	Height of Station above Sea Level.	Year 1884. Months.	Pressure of Atmosphere in Month. Mean.	Pressure of Atmosphere in Month. Range.	Temperature of Air in Month. Highest.	Lowest.	Range.	Mean. Of all Highest.	Mean. Of all Lowest.	Mean. Daily Range.	Mean Temperature. Air.	Mean Temperature. Dew Point.	Vapour. Elastic Force.	Vapour. In a Cubic foot of Air. Mean.	In a Cubic foot of Air. Short of Saturation.	Mean Degree of Humidity. Sat^n = 100.	Mean Weight of a cubic foot of Air.	Mean Reading of Thermometer. Maximum in Rays of Sun.	Mean Reading of Thermometer. Minimum on Grass.	Wind. Estimated Strength.	Wind. Relative Proportion of N.	E.	S.	W.	Mean Amount of Ozone.	Mean Amount of Cloud.	Rain. Number of Days it fell.	Rain. Amount collected.
	feet.		in.	in.	°	°	°	°	°	°	°	°	in.	grs.	gr.		grs.	°	°									in.
BATH (Somerset), St. Gregory's College, Downside, Rev. T. J. Almond, O.S.B.	596	July	29·307	0·382	74·4	47·0	27·4	66·8	53·3	13·5	58·4	53·4	·400	4·4	1·0	84	523	123·1	44·1	1·6	2	2	13	14	—	6·5	20	4·88
		Aug.	29·347	0·648	85·2	45·0	40·2	70·5	52·8	17·7	60·5	52·7	·397	4·5	1·4	77	522	121·1	41·2	1·4	2	4	11	14	—	4·7	9	2·43
		Sept.	29·188	0·828	77·4	39·5	37·9	64·6	51·1	13·5	56·7	51·5	·381	4·3	0·9	83	526	124·2	30·8	1·0	8	5	8	9	—	5·3	19	3·62
MARLBOROUGH (Wilts), Rev. Thomas A. Preston, M.A., F. R. Met. Soc.	456	July	29·453	0·570	78·0	40·2	37·8	69·4	53·1	16·3	60·0	53·8	·415	4·6	1·2	80	524	120·5	50·4	0·6	4	4	12	11	—	7·5	21	3·09
		Aug.	29·510	0·388	87·6	40·7	46·9	73·9	51·0	22·9	62·0	53·5	·410	4·6	1·7	74	523	116·6	46·8	0·8	4	6	6	15	—	4·5	13	1·25
		Sept.	29·511	0·983	79·3	32·7	46·6	66·2	50·1	16·1	57·3	51·2	·377	4·2	1·1	79	528	105·2	45·5	0·2	3	10	5	12	—	6·3	17	1·81
BLACKHEATH (Kent), James Glaisher, Esq., F.R.S.	150	July	29·788	0·611	86·5	48·9	37·6	72·9	54·7	18·2	63·0	54·7	·429	4·7	1·6	75	527	119·4	47·7	0·6	4	4	9	14	—	5·4	14	2·18
		Aug.	29·828	0·670	91·0	46·0	45·0	76·5	55·2	21·3	63·0	56·4	·455	4·5	1·4	79	527	129·5	44·7	0·6	7	7	5	12	—	3·4	6	0·25
		Sept.	29·850	0·952	83·0	43·8	39·2	68·2	52·6	15·6	59·7	52·9	·402	4·5	1·3	79	531	114·5	42·2	0·9	5	11	6	9	—	4·4	13	2·16
ROYAL OBSERVATORY, Greenwich, W. H. M. Christie, M.A., F.R.S., Astronomer Royal.	159	July	29·780	0·395	88·1	42·3	45·8	75·3	53·5	21·8	63·1	54·4	·424	4·7	1·8	74	525	131·0	45·9	—	—	—	—	—	4·4	7·1	16	1·77
		Aug.	29·835	0·613	91·2	45·8	48·4	78·7	53·6	25·1	65·3	54·2	·421	4·6	2·2	68	525	133·4	45·8	—	—	—	—	—	0·8	4·6	8	0·67
		Sept.	29·835	0·971	83·5	42·4	41·1	69·2	51·3	17·9	59·3	53·3	·407	4·6	1·1	81	531	115·7	43·3	—	—	—	—	—	1·6	5·9	12	2·09
WHITCHURCH RECTORY (Oxon), (near Reading), Rev. J. Slatter, M.A., F.R. Met. Soc.	150	July	29·828	0·578	84·0	38·0	46·0	72·8	49·6	23·2	60·8	54·0	·418	4·8	1·3	79	530	—	—	1·0	2	1	14	14	—	7·0	21	2·59
		Aug.	29·885	0·578	86·3	39·2	47·1	75·7	48·4	27·3	61·8	52·5	·396	4·3	1·3	79	530	—	—	0·9	3	8	8	12	—	3·4	12	0·76
		Sept.	—	—	79·0	38·3	40·7	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	13	2·16
CAMDEN SQUARE (London), G. J. Symons, Esq., F.R.S., F. R. Met Soc.	123	July	29·828	0·560	86·9	42·2	44·7	74·1	54·4	19·7	62·8	55·2	·423	4·8	1·5	75	528	111·8	50·0	—	6	15	8	2	—	6·3	17	2·45
		Aug.	29·883	0·615	92·0	45·7	46·3	77·1	54·5	22·6	65·4	52·2	·395	4·4	2·5	66	526	112·2	52·7	—	8	16	2	5	—	3·6	10	0·89
		Sept	29·883	0·990	81·5	40·6	40·9	68·8	52·3	16·5	59·8	52·1	·390	4·3	1·4	76	532	99·6	46·7	—	9	14	4	3	—	5·6	15	1·77
BARNET (Gas Works), T. H. Martin, Esq., C.E.	212	July	29·755	0·398	85·9	39·0	46·9	74·0	51·0	23·0	61·4	55·3	·437	4·9	1·2	81	528	130·3	47·2	0·7	4	3	5	19	—	6·6	13	2·14
		Aug.	29·820	0·611	90·8	40·0	50·8	76·7	49·4	27·3	62·3	53·0	·404	4·5	1·8	72	528	128·1	44·5	0·3	6	6	8	11	—	3·5	8	0·72
		Sept.	29·815	0·960	81·9	34·7	47·2	68·3	48·2	20·1	57·9	52·8	·400	4·5	0·9	83	535	108·3	45·7	0·5	6	8	6	10	—	5·7	11	1·79
OXFORD (The Observatory), E. J. Stone, Esq., M.A., F.R.S.	210	July	29·718	0·579	81·2	44·1	37·1	70·6	55·0	15·6	62·6	54·7	·428	4·8	1·5	76	526	121·4	49·3	2·0	3	4	15	9	3·2	6·4	21	2·26
		Aug.	29·780	0·644	88·6	45·4	43·2	75·3	54·2	21·1	64·6	54·5	·425	4·7	2·0	70	525	123·0	46·8	2·1	6	4	8	13	3·5	4·3	8	0·95
		Sept.	29·787	0·994	80·6	34·7	45·9	67·6	52·5	15·1	59·4	53·0	·403	4·7	1·2	80	531	111·6	46·7	2·5	5	7	10	8	1·8	5·6	12	1·80
ROYSTON (Hertfordshire), Hale Wortham, Esq., F.R.A.S., F. R. Met. Soc.	269	July	—	—	86·1	42·1	44·0	74·7	52·9	21·8	61·2	56·9	·464	5·2	0·9	86	—	—	—	—	6	4	9	12	—	6·4	15	2·08
		Aug.	—	—	92·2	41·3	50·9	77·8	55·1	24·7	63·4	56·6	·460	5·0	1·4	79	—	—	—	-	4	6	8	13	—	4·2	8	2·11
		Sept.	29·753	1·003	81·2	38·7	42·5	64·5	50·7	17·8	58·0	52·9	·401	4·6	0·9	85	531	—	—	—	5	6	7	12	—	5·3	10	1·59
BEDFORD, Cardington, Mr. J. McLaren, Assistant to S. Whitbread, Esq., M.P.	105	July	29·846	0·576	88·6	39·4	49·2	74·4	52·0	22·4	62·0	55·0	·433	4·8	1·4	76	529	110·2	48·8	0·7	4	2	9	16	—	6·3	19	3·05
		Aug	29·910	0·650	93·6	40·0	53·6	78·2	51·3	26·9	64·7	55·5	·443	4·9	1·8	73	527	106·5	48·3	0·6	6	4	10	11	—	3·9	10	1·15
		Sept.	29·907	0·944	85·4	34·0	51·4	70·1	50·3	19·8	59·1	55·5	·441	5·0	0·6	88	533	95·4	47·0	1·1	5	7	7	11	—	4·8	11	1·40
CAMBRIDGE (Trinity College), J. W. L. Glaisher, Esq., M.A., F.R.S.	40	July	29·871	0·596	88·2	41·0	47·2	76·0	52·1	23·9	62·3	57·1	·468	5·2	1·0	83	529	139·3	46·9	1·1	4	2	11	14	—	6·5	16	2·34
		Aug	29·935	0·644	91·8	41·2	50·6	78·3	51·7	26·6	63·7	51·1	·420	4·7	1·8	72	529	136·8	45·4	0·9	5	6	9	11	—	4·1	10	1·49
		Sept.	29·943	0·996	82·1	36·0	46·1	69·7	50·3	19·4	59·0	53·7	·413	4·7	0·9	83	531	119·2	43·6	1·1	6	4	9	11	—	5·8	10	1·67
RUGBY (Warwickshire), Stockton, The Rectory, Rev. W. Tuckwell.	289	July	29·780	0·563	86·2	38·0	48·2	72·3	51·4	20·9	60·3	54·6	·425	4·8	0·9	80	526	—	—	0·1	4	4	13	10	—	6·8	24	5·09
		Aug.	29·645	0·612	90·0	37·4	52·6	75·5	50·8	24·7	61·3	53·9	·415	4·6	1·2	77	526	—	—	0·5	6	6	10	9	—	5·1	11	2·35
		Sept.	29·646	1·022	84·0	32·8	51·2	68·2	48·5	19·7	57·5	52·3	·391	4·4	1·2	82	530	—	—	0·5	4	8	9	9	—	6·1	12	0·86
LOWESTOFT (Suffolk), S. H. Miller, Esq., F.R.A.S., F. R. Met. Soc.	89	April	29·721	0·658	60·0	31·3	28·7	49·9	39·3	10·6	44·0	40·5	·253	2·9	0·6	87	547	105·0	34·9	2·2	8	13	6	3	—	7·0	19	1·27
		May	29·869	1·232	71·0	34·1	36·9	59·3	45·8	13·5	51·5	45·0	·300	3·5	0·8	79	541	108·4	41·7	2·3	5	10	4	12	—	5·5	11	1·16
		June	29·921	0·758	73·9	46·0	27·9	61·5	51·3	10·2	54·8	50·1	·363	4·0	0·8	84	538	110·5	43·0	1·3	9	6	6	9	—	5·3	8	0·57
		July	29·832	0·530	78·1	48·5	29·6	67·8	57·8	10·0	61·8	56·9	·462	5·0	1·1	84	529	118·7	51·3	1·6	3	5	8	15	—	5·9	15	2·87
		Aug.	29·901	0·656	79·4	41·3	38·1	70·4	57·7	13·7	62·8	56·0	·448	5·0	1·4	79	529	117·7	51·1	1·4	6	7	9	9	—	5·2	11	0·92
		Sept	29·903	1·056	77·8	42·6	36·2	65·6	52·9	12·7	58·8	53·1	·404	4·3	1·2	72	533	105·8	47·8	2·2	5	8	7	10	—	5·6	13	4·61

MONTHLY METEOROLOGICAL TABLE FOR THE QUARTER ENDING JUNE 30TH, 1884.

The Observations have been reduced to Mean values by Glaisher's Barometrical and Diurnal Range Tables, and the Hygrometrical results have been deduced from the sixth edition of his Hygrometrical Tables.

NAMES of STATIONS and OBSERVERS.	Height of Station above Sea Level.	Year 1884. Months.	Pressure of Atmosphere in Month. Mean.	Pressure of Atmosphere in Month. Range.	Temperature of Air in Month. Highest.	Temperature of Air in Month. Lowest.	Temperature of Air in Month. Range.	Temperature of Air in Month. Mean Of all Highest.	Temperature of Air in Month. Mean Of all Lowest.	Temperature of Air in Month. Mean Daily Range.	Mean Temperature. Air.	Mean Temperature. Dew Point.	Vapour. Elastic Force.	Vapour. In a cubic foot of Air. Mean.	Vapour. In a cubic foot of Air. Short of Saturation.	Mean Degree of Humidity. Satn. = 100.	Mean Weight of a cubic foot of Air.	Mean Reading of Thermometer. Maximum in Rays of Sun.	Mean Reading of Thermometer. Minimum on Grass.	Wind. Estimated Strength.	Wind. Relative Proportion of N.	Wind. E.	Wind. S.	Wind. W.	Mean Amount of Ozone.	Mean Amount of Cloud.	Rain. Number of Days it fell.	Rain. Amount collected.
	feet.		in.	in.	°	°	°	°	°	°	°	°	in.	grs.	gr.		grs.	°	°									
GUERNSEY, ADOLPHUS COLLENETTE, ESQ., F. R. Met. Soc.	270	April	29·505	0·750	53·3	35·5	20·8	51·6	41·3	10·3	45·5	41·2	·259	3·0	0·5	85	541	102·2	37·2	0·9	8	10	6	6	1·2	6·8	19	2·38
		May	29·750	0·826	76·7	40·4	36·3	60·4	48·3	12·1	52·9	47·0	·323	3·7	0·9	85	537	110·9	43·8	0·9	7	9	4	11	2·5	4·6	12	1·00
		June	29·787	0·904	71·4	43·8	27·6	63·1	49·5	13·6	55·0	48·9	·343	3·9	1·0	80	536	114·1	44·5	0·6	11	1	2	16	4·2	5·4	10	3·18
TRURO (Cornwall), C. BARHAM, ESQ., M.D., F. R. Met. Soc.	43	April	29·745	0·930	62·0	27·0	35·0	55·7	38·8	16·9	45·0	39·4	·241	2·8	0·8	81	546	–	–	2·4	6	10	11	3	–	5·8	8	1·66
		May	29·953	0·910	76·0	32·0	44·0	62·8	45·6	17·2	51·4	44·7	·297	3·4	0·9	79	542	–	–	2·6	4	8	9	10	–	5·6	9	0·85
		June	29·989	0·800	75·0	40·0	35·0	67·4	49·9	17·5	55·1	52·1	·391	4·4	0·5	90	539	–	–	2·3	12	1	4	13	–	5·7	11	1·68
PLYMOUTH (Devon), J. MERRIFIELD, ESQ., LL.D., F.R.A.S., F. R. Met. Soc.	69	April	29·745	0·934	61·0	31·4	29·6	51·1	39·6	13·5	45·7	39·7	·245	2·8	0·7	80	545	–	–	1·2	8	12	6	4	–	6·3	12	1·72
		May	29·937	0·942	74·0	35·5	38·5	59·2	46·6	12·6	51·6	45·4	·304	3·3	0·9	79	542	–	–	1·6	4	10	5	12	–	6·1	10	1·00
		June	29·981	0·788	75·2	42·0	33·2	67·1	51·3	15·8	58·3	51·2	·379	4·3	1·3	76	535	–	–	1·1	11	3	6	10	–	5·7	8	0·73
TOTNES (Devon), T. H. EDMONDS, ESQ.	107	April	29·747	1·072	63·3	27·8	35·5	54·8	36·5	18·3	45·2	38·1	·229	2·7	0·9	76	546	–	–	1·9	9	10	5	6	–	5·6	10	2·25
		May	29·941	0·937	74·0	30·8	43·2	62·3	43·3	19·0	52·2	44·9	·299	3·4	1·1	77	541	–	–	2·7	6	9	4	12	–	6·0	11	1·82
		June	29·980	0·776	78·5	38·4	40·1	69·1	47·3	21·8	57·8	46·8	·320	3·6	1·4	73	536	–	–	1·7	15	3	4	8	–	6·6	9	1·10
TORQUAY, Babbacombe (Devon), EDWIN E. GLYDE, ESQ., F. R. Met. Soc.	305	April	29·485	1·166	57·5	33·2	24·3	50·7	39·5	11·2	44·4	37·7	·236	2·7	0·7	76	542	109·0	31·3	1·3	10	10	6	4	4·6	6·2	9	2·19
		May	29·696	1·072	72·2	37·1	35·1	59·1	45·5	13·6	51·2	43·9	·287	3·2	1·1	77	548	116·6	38·3	1·4	9	6	5	11	5·5	5·9	10	1·53
		June	29·752	0·784	76·9	41·0	35·9	66·8	50·6	16·2	57·5	48·1	·336	3·8	1·5	75	531	125·5	43·1	1·0	10	5	4	11	3·9	5·3	9	1·48
VENTNOR, (Isle of Wight) (Royal National Hospital for Consumption), HARTLEY SAGAR, ESQ.	80	April	29·694	0·728	58·1	32·5	25·6	53·0	40·5	12·5	45·7	38·8	·237	2·7	0·8	78	543	–	–	1·2	6	14	7	3	6·0	6·1	6	1·18
		May	29·912	0·942	73·1	41·5	31·6	61·0	48·1	12·9	53·0	46·0	·310	3·5	1·0	77	540	–	–	1·3	4	12	5	10	6·3	5·0	9	1·12
		June	29·930	0·830	73·2	42·8	30·4	65·5	52·0	13·5	57·0	50·1	·361	4·0	1·2	77	536	–	–	0·9	10	6	6	8	6·0	5·7	7	2·10
EASTBOURNE, Miss W. L. HALL.	12	Jan.	30·083	1·458	53·6	31·8	21·8	48·1	40·2	8·2	44·6	40·4	·252	2·9	0·5	85	553	62·6	37·4	0·2	9	1	4	17	–	–	19	4·28
		Feb.	29·844	0·952	55·5	31·0	22·5	47·9	40·0	7·9	44·0	39·6	·244	2·8	0·5	84	549	81·5	37·4	0·2	3	8	9	9	—	–	15	1·73
		Mar.	29·890	0·950	60·5	27·1	33·4	51·7	38·9	12·8	44·9	41·2	·259	3·0	0·4	84	549	92·5	37·1	0·1	9	3	8	10	—	–	9	1·78
		April	29·729	0·656	60·2	30·3	29·9	53·8	39·1	14·7	45·0	40·0	·247	2·8	0·6	83	546	105·3	35·4	0·3	6	13	9	2	1·2	–	9	2·14
		May	29·930	1·004	77·7	36·7	41·0	63·7	46·0	17·7	53·7	48·2	·337	3·6	0·8	81	539	113·9	42·9	0·4	3	7	7	13	2·4	–	6	0·35
		June	29·932	0·884	77·3	44·4	32·9	66·9	49·7	17·2	57·0	52·8	·399	4·4	0·8	83	536	112·4	47·3	0·2	11	4	6	9	1·3	–	9	1·40
OSBORNE (Isle of Wight), J. R. MANN, ESQ.	172	April	29·624	0·716	63·6	30·6	33·0	55·5	37·1	18·4	45·3	41·2	·259	3·0	0·5	86	545	108·4	35·4	-	8	9	8	5	–	6·6	9	1·29
		May	29·818	0·976	78·1	36·2	41·9	65·1	44·6	20·5	53·8	49·3	·351	3·9	0·6	84	537	118·2	42·7	0·1	5	8	10	8	–	5·0	7	1·12
		June	29·852	0·834	80·5	40·9	39·6	70·2	49·9	20·3	57·8	52·5	·393	4·4	0·9	82	533	120·4	48·5	-	9	5	6	10	–	5·2	8	2·52
BRIGHTON, F. E. SAWYER, ESQ., F. R. Met. Soc.	206	April	29·587	0·788	60·3	31·0	29·3	52·8	38·9	13·9	44·6	41·4	·260	3·0	0·4	90	544	94·3	37·1	1·1	8	10	7	5	–	6·0	10	1·36
		May	29·802	1·021	73·0	37·5	35·5	62·4	46·4	16·0	56·6	47·7	·332	3·7	1·4	72	534	103·6	40·7	1·4	3	8	9	11	–	5·4	9	0·36
		June	29·813	0·827	79·0	44·5	34·5	66·2	50·5	15·7	57·0	48·5	·341	3·8	1·4	73	534	106·1	45·8	0·9	8	5	6	11	–	6·5	9	1·85
SOUTHBOURNE, (near) Bournemouth (Hants), T. A. COMPTON, ESQ., M.D., B.A., F. R. Met. Soc.	95	April	29·699	0·760	56·6	27·4	29·2	50·8	36·8	14·0	43·7	36·7	·218	2·5	0·7	76	547	–	–	1·1	13	9	5	3	–	5·0	13	2·00
		May	29·909	0·978	72·0	36·6	35·4	60·3	44·7	15·6	52·1	43·2	·280	3·2	1·2	72	541	–	–	1·1	8	6	6	10	–	4·4	8	1·03
		June	29·933	0·818	72·9	41·7	31·2	64·5	49·9	14·6	56·3	49·6	·356	3·9	0·9	77	547	–	–	0·9	13	4	7	7	–	5·6	6	2·76
SALISBURY (Wilton House), Wilts, THOMAS CHALLIS, ESQ.	186	April	29·609	0·908	63·0	22·0	41·0	55·3	32·8	22·5	43·6	38·6	·233	2·7	0·5	82	545	100·4	31·5	1·0	9	8	6	7	–	6·2	14	1·81
		May	29·794	0·992	84·0	30·0	54·0	66·9	39·8	27·1	52·8	46·0	·311	3·5	1·0	78	538	115·8	–	1·0	4	6	7	14	–	5·6	8	0·92
		June	29·838	0·774	86·0	36·0	50·0	71·8	46·6	25·2	57·0	54·2	·421	4·6	0·6	90	534	119·1	–	1·0	16	6	2	6	–	6·7	7	3·44

Names of Stations and Observers.	Height of Station above Sea Level.	Year 1884. Months.	Pressure of Atmosphere in Month. Mean.	Pressure of Atmosphere in Month. Range.	Temperature of Air in Month. Highest.	Lowest.	Range.	Mean Of all Highest.	Mean Of all Lowest.	Mean Daily Range.	Mean Temperature. Air.	Mean Temperature. Dew Point.	Vapour. Elastic Force.	In a Cubic foot of Air. Mean.	In a Cubic foot of Air. Short of Saturation.	Mean Degree of Humidity. Satn. = 100.	Mean Weight of a cubic foot of Air.	Mean Reading of Thermometer. Maximum in Rays of Sun.	Minimum on Grass.	Wind. Estimated Strength.	Relative Proportion of N.	E.	S.	W.	Mean Amount of Ozone.	Mean Amount of Cloud.	Rain. Number of Days it fell.	Amount collected.
	feet.		in.	in.	°	°	°	°	°	°	°	°	in.	grs.	gr.		grs.	°	°									in.
BARNSTAPLE (Devon), WILLIAM KNILL, Esq.	43	April	29·750	0·900	63·0	37·0	26·0	55·9	42·8	13·1	47·8	40·6	·254	2·9	0·9	77	544	—	—	1·1	8	11	8	3	—	2·9	11	1·55
		May	29·945	0·970	81·0	37·5	43·5	65·9	50·9	15·0	56·8	47·1	·325	3·6	1·5	70	538	—	—	1·2	4	7	10	10	—	2·2	10	1·31
		June	30·044	0·800	82·0	40·0	42·0	69·4	53·7	15·7	59·5	50·2	·363	4·1	1·2	71	535	—	—	1·1	7	2	7	14	—	3·3	8	1·69
BATH (Somerset), St. Gregory's College, Downside, REV. T. J. ALMOND, O.S.B.	596	April	29·162	0·843	58·1	26·6	31·5	50·1	36·8	13·3	42·5	37·1	·222	2·6	0·6	83	538	104·1	31·9	1·3	11	7	6	6	—	6·0	12	1·84
		May	29·354	1·032	77·6	35·4	41·7	60·4	42·6	17·8	50·5	43·7	·288	3·4	0·7	79	533	114·7	34·5	1·6	8	5	6	12	—	5·3	11	2·69
		June	29·405	0·767	78·6	40·8	37·8	65·1	48·9	16·2	56·0	49·6	·358	4·0	1·0	79	529	121·4	43·3	1·1	10	3	3	14	—	6·2	10	3·38
STRATFIELD TURGIS (Hants), REV. C. H. GRIFFITH, M.A., F. R. Met. Soc.	197	April	29·603	0·764	65·9	22·9	43·0	54·2	35·5	18·7	43·9	38·6	·234	2·6	0·6	82	545	97·9	32·5	1·5	8	10	7	5	1·6	6·3	12	1·71
		May	29·800	1·069	82·5	32·4	50·1	65·2	41·8	23·4	52·7	43·9	·287	3·3	1·2	72	538	113·0	37·8	1·5	6	4	8	13	2·1	5·1	8	0·72
		June	29·839	0·771	83·3	33·9	49·4	68·9	47·6	21·3	57·0	50·6	·369	4·1	1·1	79	534	117·4	43·1	0·9	12	2	4	12	2·1	6·4	8	2·61
MARLBOROUGH (Wilts), REV. THOMAS A. PRESTON, M.A., F. R. Met. Soc.	456	April	29·307	0·790	60·5	23·2	37·3	51·0	35·5	15·5	42·0	35·7	·211	2·4	0·7	77	541	97·7	28·8	0·6	8	13	6	3	—	6·8	13	1·51
		May	29·493	1·064	78·4	33·0	45·4	62·4	42·1	20·3	51·6	43·1	·279	3·1	1·2	73	534	113·7	37·6	1·0	5	9	5	12	—	5·6	11	1·13
		June	29·542	0·770	83·0	35·4	47·6	66·7	48·0	18·7	56·3	49·8	·359	4·1	1·0	79	530	118·2	45·0	0·4	13	5	4	8	—	7·0	10	3·51
BLACKHEATH (Kent), JAMES GLAISHER, Esq., F.R.S.	150	April	29·649	0·762	69·0	30·0	39·0	53·7	38·4	15·3	45·1	39·5	·242	2·8	0·6	80	544	97·6	30·9	0·7	12	8	8	2	—	7·1	11	1·12
		May	29·826	1·088	81·0	36·1	44·9	64·7	45·1	19·6	54·1	46·0	·309	3·5	1·2	73	537	119·6	37·4	1·1	2	11	8	11	—	4·7	10	0·93
		June	29·864	0·794	82·0	44·5	37·5	67·2	50·3	16·9	57·6	51·5	·381	4·2	1·1	80	534	105·3	43·1	0·4	12	5	2	11	—	6·5	8	2·11
ROYAL OBSERVATORY, Greenwich, W. H. M. CHRISTIE, M.A., F.R.S., Astronomer Royal.	159	April	29·645	0·705	68·7	27·0	41·7	54·3	37·1	17·2	45·1	39·3	·240	2·8	0·6	80	544	104·6	32·2	—	—	—	—	—	3·5	7·5	15	1·11
		May	29·824	1·099	80·5	35·6	44·9	65·7	43·8	21·9	54·3	44·9	·298	3·4	1·4	71	537	120·1	37·1	—	—	—	—	—	4·1	5·5	10	0·96
		June	29·857	0·779	82·6	42·7	39·9	69·3	49·1	20·2	58·0	51·0	·374	4·2	1·1	78	533	119·8	42·2	—	—	—	—	—	2·2	6·7	8	2·24
WHITCHURCH RECTORY (Oxon), (near Reading), REV. J. SLATTER, M.A., F.R. Met. Soc.	150	April	29·669	0·731	65·4	26·0	39·4	54·3	35·5	18·8	44·6	38·3	·231	2·6	0·7	78	535	—	—	1·0	9	13	6	2	—	7·0	17	1·84
		May	29·867	1·025	79·5	31·6	47·9	66·1	40·9	25·2	53·4	44·8	·297	3·4	1·1	73	530	—	—	1·3	3	11	8	9	—	4·9	12	0·61
		June	29·891	0·722	81·9	35·0	46·9	69·0	47·0	22·0	57·9	49·2	·350	3·9	1·5	74	534	—	—	0·9	13	6	3	8	—	6·3	7	2·48
CAMDEN SQUARE (London), G. J. SYMONS, Esq., F.R.S., F. R. Met. Soc.	123	April	29·689	0·722	68·4	29·9	38·5	54·9	37·8	17·1	45·4	37·5	·224	2·6	0·9	74	545	87·6	34·2	—	14	12	2	2	—	6·4	14	1·02
		May	29·866	1·069	81·3	35·0	46·3	66·3	44·7	21·6	54·2	44·2	·289	3·4	1·3	67	5[illegible]6	102·2	40·9	—	7	14	3	7	—	5·2	11	0·78
		June	29·905	0·790	81·7	40·6	41·1	69·7	50·0	19·7	58·2	49·5	·354	3·9	1·3	73	534	107·3	45·7	—	15	11	0	4	—	6·4	7	2·84
BARNET (Gas Works), T. H. MARTIN, Esq., C.E.	212	April	29·624	0·706	67·7	21·2	46·5	54·2	34·5	19·7	43·4	38·6	·234	2·7	0·5	84	545	104·4	30·2	0·5	5	17	5	3	—	7·3	10	0·92
		May	29·802	1·077	79·0	30·4	48·6	65·1	41·0	24·1	52·2	45·3	·303	3·4	1·0	78	539	120·9	36·9	0·7	3	11	3	14	—	4·9	10	1·14
		June	29·841	0·764	81·6	34·2	37·4	68·9	46·5	22·4	55·9	50·1	·364	4·1	1·9	82	535	129·8	42·5	0·4	9	10	2	9	—	6·6	7	2·73
OXFORD (The Observatory), E. J. STONE, Esq., M.A., F.R.S.	210	April	29·602	0·725	64·1	27·0	37·1	52·9	38·2	14·7	45·4	39·0	·237	2·7	0·7	78	543	102·6	32·1	2·0	11	9	7	3	3·0	6·6	13	1·71
		May	29·770	1·[illegible]27	78·6	36·6	42·0	63·5	44·5	19·0	54·1	43·4	·280	3·2	1·5	67	536	113·0	37·3	3·1	6	7	10	8	4·8	5·3	11	0·80
		June	29·815	0·743	79·9	37·8	42·1	66·8	49·8	17·0	58·3	49·7	·358	3·9	1·5	75	532	116·7	44·2	1·9	11	6	3	10	4·4	6·2	7	2·15
ROYSTON (Hertfordshire), HALF WORTHAM, Esq., F.R.A.S., F. R. Met. Soc.	269	April	29·575	0·670	67·4	24·7	42·7	54·4	35·6	18·8	43·3	38·3	·231	2·7	0·6	82	545	—	—	—	12	9	7	2	—	7·1	12	1·00
		May	29·740	1·19[illegible]	84·0	34·2	48·8	67·5	42·1	25·4	52·7	46·1	·311	3·4	1·0	78	537	—	—	-	6	8	6	11	—	4·8	3	0·44
		June	29·775	0·774	81·5	37·8	43·7	66·6	47·7	18·9	55·6	49·6	·356	4·0	0·9	81	535	—	—	—	12	5	6	7	—	6·0	7	1·27
BEDFORD, Cardington, MR. J. MCLAREN, Assistant to S. WHITBREAD, Esq., M.P.	105	April	29·726	0·790	69·0	22·0	47·0	54·5	35·5	19·0	44·0	37·7	·226	2·6	0·7	76	547	87·6	31·3	0·9	8	12	6	4	—	6·3	16	1·16
		May	29·891	1·15[illegible]	85·0	31·0	54·0	67·0	41·7	25·3	53·4	43·4	·282	3·2	1·2	69	539	101·0	38·7	2·0	4	8	5	14	—	4·5	7	0·84
		June	29·937	0·740	86·0	36·6	49·4	69·9	47·9	22·0	57·4	50·5	·368	4·1	1·2	78	5[illegible]6	107·8	45·1	0·5	12	7	3	8	—	5·9	7	2·10
CAMBRIDGE (Trinity College), J. W. L. GLAISHER, Esq., M.A., F.R.S.	40	April	29·769	0·692	69·5	24·5	46·0	55·2	35·0	20·2	43·9	38·0	·229	2·6	0·7	80	548	11[illegible]·4	29·1	1·1	10	9	6	5	—	7·0	14	1·22
		May	29·926	1·148	81·2	33·0	48·2	66·4	41·7	24·7	53·0	45·6	·306	3·5	1·0	78	540	132·4	34·8	1·5	5	8	9	9	—	4·5	9	0·84
		June	29·968	0·756	80·9	39·1	41·8	70·0	46·5	23·5	54·3	51·1	·379	4·2	0·9	83	537	136·4	39·9	0·9	6	7	5	12	—	6·0	8	1·34
RUGBY (Warwickshire), Stockton, The Rectory, REV. W. TUCKWELL.	289	April	29·474	0·744	65·0	21·6	43·4	54·0	34·2	19·8	42·8	39·5	·243	2·8	0·5	88	543	—	—	0·6	13	10	4	3	—	7·2	16	1·94
		May	29·623	1·098	78·3	31·0	47·3	64·6	41·8	21·8	52·0	44·5	·293	3·4	1·0	78	536	—	—	0·8	6	8	9	8	—	5·6	11	1·18
		June	29·692	0·706	84·1	35·0	49·1	68·7	46·1	22·6	55·0	48·0	·335	3·8	1·1	77	544	—	—	0·4	10	6	2	12	—	7·0	10	1·26

Names of Stations and Observers.	Height of Station above Sea Level.	Year 1884. Months.	Pressure of Atmosphere in Month. Mean.	Pressure of Atmosphere in Month. Range.	Temperature of Air in Month. Highest.	Temperature of Air in Month. Lowest.	Temperature of Air in Month. Range.	Temperature of Air in Month. Mean. Of all Highest.	Temperature of Air in Month. Mean. Of all Lowest.	Temperature of Air in Month. Mean. Daily Range.	Mean Temperature. Air.	Mean Temperature. Dew Point.	Vapour. Elastic Force.	Vapour. In a cubic foot of Air. Mean.	Vapour. In a cubic foot of Air. Short of Saturation.	Mean Degree of Humidity. Satn. = 100.	Mean Weight of a cubic foot of Air.	Mean Reading of Thermometer. Maximum in Rays of Sun.	Mean Reading of Thermometer. Minimum on Grass.	Wind. Estimated Strength.	Wind. Relative Proportion of N.	Wind. Relative Proportion of E.	Wind. Relative Proportion of S.	Wind. Relative Proportion of W.	Mean Amount of Ozone.	Mean Amount of Cloud.	Rain. Number of Days it fell.	Rain. Amount collected.
	feet.		in.	in.	°	°	°	°	°	°	°	°	in.	grs.	gr.		grs.	°	°									in.
LOWESTOFT (Suffolk), S. H. Miller, Esq., F.R.A.S., F. R. Met. Soc.	89	April	29·721	0·658	60·0	31·3	28·7	49·9	39·3	10·6	44·0	40·5	·253	2·9	0·6	87	547	105·0	34·9	2·2	8	13	6	3	–	7·0	19	1·27
		May	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
		June	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
SOMERLEYTON (Suffolk), The Rectory, Rev. C. J. Steward, F. R. Met. Soc.	50	April	29·772	0·626	61·5	30·0	31·5	51·2	38·4	12·8	43·5	38·8	·236	2·8	0·5	83	548	–	–	1·0	9	12	6	3	4·4	6·3	15	1·17
		May	29·957	1·158	72·0	33·6	38·4	60·1	44·4	15·7	50·8	44·9	·298	3·4	0·8	85	543	–	–	1·0	7	8	7	9	4·4	5·0	7	1·23
		June	29·963	0·748	75·6	40·0	35·6	62·5	44·6	17·9	52·4	47·6	·330	3·7	0·7	84	541	–	–	1·0	9	9	6	6	4·3	5·3	7	0·79
WOLVERHAMPTON (Staffordshire), Wrottesley, E. Simpson, Esq.	500	April	29·318	0·850	61·5	25·0	36·5	51·4	35·1	16·3	42·3	35·4	·208	2·5	0·8	78	541	–	–	–	11	11	6	2	–	7·9	12	1·61
		May	29·470	1·164	78·0	31·6	46·4	61·2	41·2	20·0	50·1	40·0	·248	2·8	1·3	68	536	–	–	–	4	9	9	9	–	6·7	11	1·10
		June	29·530	0·694	81·5	37·6	43·9	65·2	46·0	19·2	54·3	44·8	·297	3·4	1·4	68	532	–	–	–	11	4	4	11	–	7·2	9	2·05
LEICESTER (Town Museum), J. C. Smith, Esq.	238	April	29·561	0·819	67·5	26·2	41·3	53·1	38·1	15·0	44·7	38·2	·231	2·6	0·7	78	543	99·7	30·0	0·5	10	10	7	3	–	6·8	20	1·86
		May	29·704	1·216	80·0	34·9	45·1	63·4	43·4	20·0	52·7	42·9	·277	3·1	1·5	69	537	108·0	34·5	0·8	7	6	8	10	–	4·8	13	1·24
		June	29·771	0·762	83·0	33·6	49·4	68·1	48·0	20·1	57·4	50·5	·368	4·1	1·2	78	533	112·7	39·3	0·4	11	7	5	7	–	6·6	12	1·86
NOTTINGHAM (Notts), M. O. Tarbotton, Esq., C.E., F.G.S., F. R. Met. Soc.	183	April	29·627	0·786	66·2	25·1	41·1	53·8	37·2	16·6	44·4	37·3	·222	2·6	0·7	75	545	85·7	35·5	0·3	6	18	6	0	1·2	7·5	19	1·76
		May	29·765	1·236	80·1	31·3	48·8	66·2	43·1	23·1	52·6	43·3	·280	3·2	1·3	70	538	105·3	40·1	0·4	2	11	10	8	2·3	5·6	13	0·86
		June	29·823	0·716	85·8	33·9	51·9	70·3	47·2	23·1	56·7	47·3	·334	3·7	1·4	72	534	111·4	44·2	0·2	6	13	6	5	1·2	6·6	11	1·22
HOLKHAM (Norfolk), John Davidson, Esq., Assistant to the Earl of Leicester.	39	April	29·768	0·688	68·0	26·3	41·7	52·3	34·3	18·0	43·5	39·5	·244	2·8	0·5	86	548	112·1	27·1	1·2	14	8	6	2	–	5·7	14	1·41
		May	29·904	1·238	75·4	27·6	47·8	61·2	39·3	21·9	49·8	43·0	·278	3·4	0·9	78	543	124·0	33·8	1·6	9	6	9	7	–	4·7	7	0·80
		June	29·961	0·730	75·8	36·0	39·8	63·9	42·9	21·0	52·4	45·7	·309	3·5	1·0	79	542	136·1	37·0	1·1	16	4	6	4	–	4·7	6	0·50
BURSLEM, J. E. Worth, Esq., C.E., F. R. Met. Soc.	556	April	29·223	0·904	62·2	28·5	33·7	51·6	36·8	14·8	43·2	37·3	·222	2·6	0·6	80	538	–	32·9	0·8	7	13	6	4	–	7·5	16	1·52
		May	29·354	1·248	75·7	34·5	41·2	60·6	42·7	17·9	50·6	42·0	·267	3·1	1·1	73	533	–	38·7	1·1	3	9	10	9	–	5·3	12	1·52
		June	29·443	0·747	79·2	38·3	40·9	66·5	47·3	19·2	55·5	47·3	·328	3·7	1·2	74	529	–	42·9	0·8	10	4	3	13	–	6·3	10	1·90
LLANDUDNO (Carnarvonshire), James Nicol, Esq., M.D.	100	April	29·720	1·070	57·6	31·2	26·4	50·2	39·4	10·8	44·9	38·4	·233	2·7	0·7	78	546	–	–	0·8	6	13	7	14	–	6·1	11	1·19
		May	29·850	1·300	75·2	40·0	35·2	58·7	46·1	12·6	51·7	43·7	·284	3·2	1·0	74	541	–	–	1·0	1	9	6	15	–	5·7	7	1·35
		June	29·942	0·850	81·0	41·5	39·5	63·0	49·9	13·1	55·6	47·5	·330	3·7	1·2	74	538	–	–	0·8	7	2	2	9	–	6·6	6	1·18
LIVERPOOL, The Observatory, John Hartnup, Esq., F.R.A.S.	197	April	29·615	0·790	63·4	30·7	32·7	52·0	39·9	12·1	44·6	37·2	·221	2·5	0·6	72	544	–	–	1·1	8	14	8	0	–	6·0	15	1·23
		May	29·721	1·269	79·2	38·4	40·8	60·0	45·5	14·5	51·0	43·2	·280	3·2	1·0	75	539	–	–	1·9	1	11	7	12	–	5·1	8	1·23
		June	29·831	0·812	81·2	45·9	35·3	63·8	51·1	12·7	56·0	47·1	·326	3·6	1·6	72	535	–	–	1·3	5	3	3	19	–	5·1	8	0·78
BOLTON, Sharples (Lancashire), Rev. T. Mackereth, F.R.A.S., F. R. Met. Soc.	500	April	29·295	0·912	62·8	29·0	33·8	50·8	36·6	14·2	42·8	36·4	·215	2·5	0·7	79	540	66·7	34·6	0·5	8	13	6	3	2·6	6·8	15	0·97
		May	29·407	1·294	76·1	33·9	42·2	59·2	42·3	16·9	49·3	42·1	·269	3·0	0·9	75	535	71·5	40·2	1·0	5	7	8	11	4·1	6·5	11	2·30
		June	29·502	0·752	80·2	38·5	41·7	64·0	47·0	17·0	54·2	48·3	·357	3·9	0·9	80	531	81·3	44·1	0·5	10	5	4	11	3·4	6·3	7	0·78
HALIFAX, Bermerside Observatory (Yorkshire), E. J. Crossley, Esq., F.R.A.S.	530	April	29·305	0·858	62·3	26·5	35·8	51·3	35·5	15·8	41·6	37·1	·222	2·6	0·5	85	542	84·3	33·0	0·5	9	13	5	3	–	7·5	14	2·10
		May	29·408	1·297	79·9	33·0	46·9	61·3	40·5	20·8	50·0	39·1	·241	2·8	1·3	67	535	101·7	37·7	1·2	4	5	11	11	–	5·5	9	1·83
		June	29·510	0·722	81·3	36·5	44·8	65·1	45·0	20·1	53·8	45·5	·304	3·4	1·2	74	532	103·3	42·0	0·6	6	8	7	9	–	6·9	8	1·05
HULL (Yorkshire), The People's Park, Mr. E. Peak.	12	April	29·881	0·780	61·0	26·0	35·0	51·8	36·2	15·6	44·1	36·5	·215	2·5	0·8	74	549	76·3	35·4	1·2	14	9	6	1	–	6·8	21	1·77
		May	29·941	1·288	79·0	33·0	46·0	62·2	41·8	20·4	51·8	44·2	·290	3·3	1·0	85	542	86·3	40·8	1·6	1	5	7	18	–	4·8	12	0·66
		June	30·045	0·710	83·0	34·0	49·0	67·1	45·5	21·6	55·8	47·3	·329	3·7	1·3	78	539	92·9	44·4	0·9	5	5	10	10	–	5·5	6	0·85
STONYHURST (Lancashire), Rev. S. J. Perry, F.R.S., F. R. Met. Soc., F.R.A.S.	363	April	29·457	0·955	68·8	28·0	40·8	54·7	35·5	19·2	44·1	37·0	·219	2·5	0·8	75	542	72·1	32·1	–	9	15	3	3	–	7·8	16	1·01
		May	29·555	1·324	77·9	32·0	45·9	61·1	40·5	20·6	49·5	42·3	·271	3·1	0·8	76	538	112·1	37·0	–	3	6	5	17	–	6·1	13	2·32
		June	29·655	0·741	80·0	39·0	41·0	66·9	45·4	21·5	54·7	46·5	·316	3·5	1·3	73	534	118·7	41·5	–	8	5	1	16	–	7·4	8	1·12
BRADFORD (Yorkshire), J. McLandsborough, Esq., C.E., F.G.S.	366	April	29·489	0·866	61·0	30·4	30·6	51·1	38·5	12·6	43·3	36·5	·216	2·5	0·8	75	542	69·7	–	0·6	10	12	5	3	–	7·8	21	2·09
		May	29·537	1·336	83·9	38·0	45·9	61·8	44·5	17·3	50·8	41·4	·261	3·0	1·2	71	536	79·8	–	1·1	5	7	8	11	–	7·1	14	1·50
		June	29·651	0·701	83·4	40·7	42·7	64·9	48·9	16·0	55·2	46·2	·314	3·6	1·4	72	533	82·1	–	0·4	10	6	5	9	–	7·7	10	1·03

Names of Stations and Observers.	Height of Station above Sea Level.	Year 1884. Months.	Pressure of Atmosphere in Month. Mean.	Pressure of Atmosphere in Month. Range.	Temperature of Air in Month. Highest.	Temperature of Air in Month. Lowest.	Temperature of Air in Month. Range.	Temperature of Air in Month. Mean. Of all Highest.	Temperature of Air in Month. Mean. Of all Lowest.	Temperature of Air in Month. Mean. Daily Range.	Mean Temperature. Air.	Mean Temperature. Dew Point.	Vapour. Elastic Force.	Vapour. In a cubic foot of Air. Mean.	Vapour. In a cubic foot of Air. Short of Saturation.	Mean Degree of Humidity. Satn. = 100.	Mean Weight of a cubic foot of Air.	Mean Reading of Thermometer. Maximum in Rays of Sun.	Mean Reading of Thermometer. Minimum on Grass.	Wind. Estimated Strength	Wind. Relative Proportion of N.	Wind. Relative Proportion of E.	Wind. Relative Proportion of S.	Wind. Relative Proportion of W.	Mean Amount of Ozone.	Mean Amount of Cloud.	Rain. Number of Days it fell.	Rain. Amount collected.
	feet.		in.	in.	°	°	°	°	°	°	°	°	in.	grs.	gr.		grs.	°	°									in.
LEEDS (Yorkshire), The Philosophical Hall, HENRY CROWTHER, Esq.	137	April	29·675	0·854	67·0	31·0	36·0	53·7	39·4	14·3	45·4	38·1	·230	2·7	0·8	76	544	—	—	1·0	7	15	4	4	—	7·6	19	1·82
		May	29·791	1·292	81·0	37·0	44·0	63·3	45·0	18·3	53·2	39·6	·244	2·8	1·6	60	538	—	—	1·1	3	8	7	13	—	5·9	11	1·12
		June	29·875	0·700	83·0	40·0	43·0	67·5	49·2	18·3	57·5	44·5	·294	3·3	2·1	62	535	—	—	1·0	7	7	3	13	—	6·5	7	0·74
LANCASTER (Southfields), WILLIAM ROPER, Esq.	114	April	29·691	0·992	65·0	30·0	35·0	53·3	37·5	15·8	44·7	42·1	·269	3·0	0·3	91	545	—	—	—	—	—	—	—	—	—	14	1·34
		May	29·805	1·291	75·0	36·7	38·3	59·4	43·0	16·4	50·1	47·8	·333	3·8	0·3	92	541	—	—	—	—	—	—	—	—	—	13	2·65
		June	29·850	0·719	83·0	41·0	42·0	65·1	47·3	17·8	55·2	50·5	·368	4·1	0·8	85	544	—	—	—	—	—	—	—	—	—	8	0·90
SILLOTH (Cumberland), "The Rectory," REV. F. REDFORD, M.A., F.R.A.S., F. R. Met. Soc.	28	April	29·817	1·083	61·6	31·0	30·6	51·3	36·2	15·1	44·2	41·4	·261	3·0	0·4	90	548	101·5	33·5	1·3	6	15	5	4	8·0	6·2	14	1·25
		May	29·870	1·402	73·9	32·0	41·9	58·5	42·6	15·9	49·7	42·9	·277	3·1	1·0	78	543	104·9	38·6	1·8	1	10	6	14	9·6	5·0	14	2·77
		June	29·994	0·805	83·2	39·4	43·8	66·0	47·6	18·4	55·9	47·9	·329	3·7	1·2	75	538	118·6	43·8	1·1	5	8	5	12	6·9	5·8	8	0·46
CARLISLE, Spital (Cumberland), ISAAC CARTMEL, Esq., F. R. Met. Soc	114	April	29·733	1·008	64·6	27·6	39·0	55·1	35·5	19·6	44·2	37·7	·226	2·7	0·7	77	547	88·9	29·8	0·7	5	13	3	9	2·4	7·8	11	1·46
		May	29·766	1·398	78·8	30·8	48·0	60·7	40·5	20·2	49·5	43·1	·279	3·2	1·0	79	541	96·4	36·3	1·0	5	7	5	14	3·0	7·2	12	2·50
		June	29·888	0·782	86·2	35·4	50·8	69·0	46·6	22·4	56·0	49·2	·353	3·9	1·1	78	536	105·6	43·5	0·6	4	6	4	16	2·6	7·9	6	0·36

Second Rain-gauges are placed—

			January.		February.	March.	April.	May.	June	Total in Quarter.
At Eastbourne, at the height of	160	feet *above the sea*; the amount collected was	3·86 inches.	-	1·65 inches.	2·11 inches.	1·98 inches.	0·37 inches.	1·40 inches.	3·75 inches.
" Beachy Head "	515	" " "	2·78 "	-	1·43 "	1·34 "	1·60 "	0·20 "	1·40 "	3·20 "
" " "	495	" " "	2·85 "	-	1·46 "	1·84 "	1·86 "	0·27 "	1·44 "	3·57 "
" Oxford "	22	" *ground* "	— "	-	— "	— "	1·54 "	0·76 "	2·11 "	4·41 "
" Cardington "	21	" " "	— "	-	— "	— "	1·20 "	0·90 "	— "	— "
" Nottingham "	39	" " "	— "	-	— "	— "	1·61 "	0·76 "	1·13 "	3·50 "
" Holkham "	4	" " "	— "	-	— "	— "	— "	0·80 "	0·50 "	— "